

An Ecological Biosecurity Plan

To Prevent Spread of Non-Native Species on Alaska Maritime National Wildlife Refuge



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Central cover image: Buldir Island (Ronan Dugan/USFWS)

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INTRODUCTION

DEFINITIONS: What is Biosecurity?

Broadly, biosecurity is the sum of risk management actions taken in defense against biological threats (Meyerson and Reaser 2002). This plan focuses on *ecological biosecurity*, which we choose to define as: a strategy and set of procedures to prevent the introduction and spread of organisms that threaten native natural resources and ecology.

In addition, there is often confusion surrounding the terms *non-native* and *invasive* species. For clarity, we provide the following definitions:

Non-native Species – an individual, group, or population of a species, subspecies, or lower taxon that is introduced by human intervention into an area or ecosystem outside its natural past or present distribution. Synonymous with “alien,” “non-indigenous,” “exotic,” and “introduced.”

Invasive Species – a non-native organism whose introduction does or is likely to cause environmental or economic damage or harm to human health. Referred to in ecological contexts as invasive alien species (IAS), their introduction and/or spread outside their natural past or present distribution threatens biological diversity.

Non-native species: *exists where it has not naturally occurred, but may not be a cause for concern if it does not damage the ecosystem*

Invasive species: *non-native species that causes harm*

In biology, a non-native species did not originate in a given habitat, but may have a neutral or even positive effect on the ecosystem. An invasive species has a negative effect on the ecosystem. Invasive species are, by definition, harmful.

It is a challenge to predict when and how a non-native species might threaten the native biological diversity of this Refuge’s resources and become designated as an invasive species. ***For this reason, the most conservative action is to treat all non-native species as potential invaders.***

PURPOSE: Why have a Biosecurity Plan?

The National Wildlife Refuge System is obligated to protect and conserve fish, wildlife, and their habitats. The Alaska Maritime National Wildlife Refuge is truly outstanding in geography and scale: several thousand coastal islands and headlands span the equivalent distance of Georgia to California and provide critical habitat to millions of seabirds. Though remote, these lands have a history of accidental and intentional species introductions that resulted in devastation to valuable natural resources, particularly seabird colonies. The Refuge is dedicated to restoring native ecosystems in the wake of these introductions and maintaining pest-free ecosystems into the future. So far, programming has largely focused on restoration through targeted eradication efforts of fox, rabbit, and rat populations. The creation and implementation of this biosecurity plan signals a shift towards holistic prevention that accounts for a broader spectrum of biological threats and the myriad of vectors by which they can be introduced. Biosecurity is inherently less exciting than the swashbuckling heroics of eradication missions, but it is several orders of magnitude more cost effective. The purpose of this plan is to ignite a culture of biosecurity on the Refuge and provide clear expectations and protocols for employees and visitors in a simple, concise package. This plan will be a functional guide for protecting the unique lands and resources of the Refuge from biological threats so that they remain intact for the continuing benefit of the American people.

AUDIENCE: Who is this plan for?

All visitors to the Refuge have a responsibility to actively protect the lands and species they are working to conserve. The intended audience of this plan includes: Refuge employees and volunteers, permittees, contractors, and the visiting public.

It is up to everyone that visits the Refuge to hold themselves and those around them accountable to following the guidance provided in this document. This program will only be successful if all Refuge visitors take individual and collective ownership to prevent introductions.

REFUGE DESCRIPTION: What resources are being protected?

The Alaska Maritime National Wildlife Refuge comprises over 3,000 headlands, islands, islets, rocks, tidelands, submerged lands, and waters, which together supply a crucial link between wildlife and the marine environment. The Refuge totals nearly 5 million acres, and is broken into five geographic units (Figure 1). These units are typically accessed by ship or aircraft. Vignettes of each unit's resources are described below.



Before and after a rat incursion (paintings by Ram Papish)



Figure 1. Map showing monitoring sites (yellow circles) and the five geographical units (labelled in white) of the Alaska Maritime National Wildlife Refuge.



Cape Lisburne, 2012 (Arthur Kettle/USFWS)

Chukchi Sea Unit

The northernmost Refuge unit is comprised of treeless areas of permafrost and high coastal escarpments as well as low, sandy, barrier islands. The striking cliffs at Capes Lisburne and Thompson in the Chukchi Sea support an estimated 1,000,000 seabirds, the largest seabird colonies in Arctic Alaska. Thick-billed murres are the majority of the breeding birds on these cliffs. Marine mammals such as harbor, ribbon, ringed, and bearded seals; walrus; and polar bears are common along the coast. In contrast to the rest of the marine-dependent refuge, the interior portions of the unit support populations of iconic Arctic mammals: caribou, muskox, wolves, wolverine, and grizzly bears.



St. George Island, 2010 (USFWS)

Bering Sea Unit

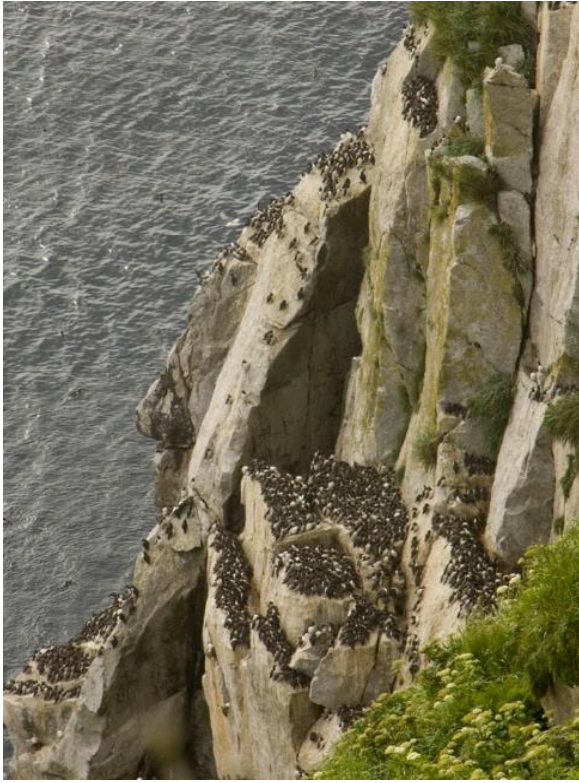
Treeless marine tundra characterizes the several islands and headlands on Norton Sound, extensive wilderness on St. Matthew Island, the Pribilof Islands' unequalled bird cliffs, Hagemeister Island, and other smaller islands in the Bering Sea. Within this unit, millions of thick-billed and common murres nest in immense colonies alongside red-legged and black-legged kittiwakes. The cliffs of St. George Island are home to over 70% of the world's population of red-legged kittiwakes. Three endemic species are found solely on Refuge land within this unit: the Pribilof shrew, the Insular/St. Matthew singing vole, and the McKay's bunting.



Islands of the 4 Mountains, 2013 (USFWS)

Aleutian Islands Unit

Smoking volcanoes and frequent earthquakes are physical clues of the massive tectonic forces that fomented this 1,000 mile long archipelago. The maritime tundra along the coast is wind raked and treeless, while inland peaks reach summits of 9,000 feet. Between the islands, currents rip through shallow passes and advect rich sources of plankton that reliably nourish tens of millions of seabirds and hundreds of thousands of marine mammals. Burrow- and crevice-nesting tufted and horned puffins, along with several species of auklets, breed in huge colonies and display sweeping spectacles of aerial flight to the delight of visitors.



Chowiet Island murre colony (USFWS)

Alaska Peninsula Unit

Every year, millions of marine seabirds flock to this unit's 800 isolated, rugged, storm-lashed islands south of the Alaska Peninsula to breed. Species diversity is higher here than anywhere else on the Refuge, especially on the Shumagin Islands and Sandman Reefs: murre, kittiwake, puffin, crested auklet, storm-petrel, ancient murrelet, and even ptarmigan abound. Islands devoid of foxes are the breeding grounds for the majority of Alaska's nocturnal seabirds. Sea otters, sea lions, and harbor seals are particularly abundant in the vicinity of small remote islands, seastacks, and reefs scattered along the Unit's entire coastline.



St. Lazaria Island, 2019 (Brie Drummond/USFWS)

Gulf of Alaska Unit

The southernmost unit is dominated by lush rain forest. It spans the Gulf of Alaska, and includes the islands and rocks in Cook Inlet; the Chiswell and Pye Islands off the coast of the Kenai Peninsula; islands and waters surrounding Kodiak and Afognak Islands; and Forrester, Hazy, and St. Lazaria islands in southeastern Alaska. Notable here are sightings of over 500,000 murre, kittiwake, puffin, storm-petrel, cormorant, and other seabirds swarming the Barren Islands at the entrance to Cook Inlet and thousands of storm-petrels and rhinoceros auklets breeding on St. Lazaria and Forrester islands.

Additional Notable Species

In addition to the abundance of seabirds, the Refuge also hosts many 'mainland' bird species. Shorebirds, sea ducks, raptors, and passerines live throughout the units. During migration seasons, a subset of the reefs and islands teem with black brant, emperor geese, scoters, eiders, and large numbers of other waterfowl and shorebirds. Finally, hundreds of pairs of bald eagles nest on islands and mainland cliffs, and peregrine falcons nest near some of the important small alcid colonies.

NON-NATIVE SPECIES ON THE REFUGE: What are the threats?

A common misconception about Alaska is that it is free of non-native species due to its cold climate and geographic isolation. While Alaska has fewer non-native species than states in the lower 48, many will be surprised to learn that hundreds of species of non-native animals and plants are present in the Last Frontier, and several of them are capable of environmental and economic damage. A report from the Alaska Natural Heritage Program found that, “A total of 116 non-native animal species (including fishes, amphibians, reptiles, birds, mammals, invertebrates, parasites, and pathogens) were documented as present (either historically or currently) in the state, of which 20 were designated as highly invasive species” (McClory and Cotthardt 2008). In addition, the Alaska Center for Conservation Science has been tracking all non-native plants known to occur on Alaska’s public lands since 2002. The current list contains 165 species (AKEPIC, accessed July 2019). The U.S. Forest Service selected 53 non-native plant species present in Alaska as high-priority threats (Shephard et al. 2004).

Only a small percentage of the Refuge has been sampled for non-native terrestrial plants and vertebrates, so the data are limited and biased. The best available records show there are 42 species of non-native plants, 14 species of non-native vertebrates, and 4 non-native terrestrial invertebrates present on Refuge lands. Appendix 1 contains an alphabetical table of 40 sampled islands with their associated non-native species. This appendix also contains a table of non-native marine species that have been detected on or near submerged lands and waters of the Refuge.

LEGAL PRECEDENT FOR BIOSECURITY

Biosecurity plans and protocols comply with legal expectations. The precedent for the prevention and control of non-native and introduced species on the Alaska Maritime Refuge is set through Acts of Congress, Alaska Legislature, Executive Orders, and agency and refuge policies. Specific language from each are highlighted and emphasized below.

Federal Laws

- Alaska National Interest Lands Conservation Act [section 303 (1)(b)(i)]
“The purposes for which the Alaska Maritime National Wildlife Refuge is established and shall be managed include— (i) to conserve fish and wildlife populations and habitats in their *natural diversity...*”
- Code of Federal Regulation for the National Wildlife Refuge System [50 CFR 27.52]
“*Plants and animals or their parts taken elsewhere shall not be introduced, liberated, or placed on any National Wildlife Refuge except as authorized.*”
- National Invasive Species Act
“*The purposes of this Act are— (1) to prevent unintentional introduction and dispersal of nonindigenous species into waters of the United States through ballast water management and other requirements; (2) to coordinate federally conducted, funded or authorized research, prevention control, information dissemination and other activities regarding the zebra mussel and other aquatic nuisance species; (3) to develop and carry out environmentally sound control methods to prevent, monitor and control unintentional introductions of nonindigenous species from pathways **other** than ballast water exchange...*”
- Lacey Act
Prevents the spread of non-native species by regulating the import of plants and wildlife.

State Laws

- Alaska Rodent Laws [2014; 5 AAC 92.141]
Prohibit the transport, harboring, or release of live uncaged Muridae rodents.
- Alaska Ban on Felt-Soled Boots [5 AAC 75.022.d]
“Beginning January 1, 2012, the use of footwear with absorbent felt or other fiber material on the soles is prohibited while sport fishing in fresh water.”

Executive Orders

- Executive Order 13751 (2016, amendment to EO 13112 from 1996)
“Each Federal agency... shall, to the extent practicable and permitted by law...use relevant agency programs and authorities to:

(i) prevent the introduction, establishment, and spread of invasive species;

(ii) detect and respond rapidly to eradicate or control populations of invasive species in a manner that is cost-effective and minimizes human, animal, plant, and environmental health risks...

(vi) promote public education and action on invasive species, their pathways, and ways to address them, with an emphasis on prevention, and early detection and rapid response...”

Policies

- 601 FW3 (2001)
USFWS policy for maintaining and restoring the biological integrity, diversity, and environmental health of the National Wildlife Refuge System:

“(2) Biological integrity lies along a continuum from a biological system extensively altered by significant human impacts to the landscape to a completely natural system. No landscape retains absolute biological integrity, diversity, and environmental health. *However, we strive to prevent the further loss of natural biological features and processes; i.e., biological integrity.*
- Alaska Maritime National Wildlife Refuge Comprehensive Conservation Plan (1988)
Presents AMNWR’s ‘Fish and Wildlife and Habitat Management’ strategy (page III-16 & 17):

“The Service will fulfill its the Alaska Lands Act obligations to maintain natural diversity by managing indigenous populations so that they do not decline unnaturally below the levels that existed on December 2, 1980, when the refuge was established. According to legislative history, the term "natural diversity" reflects an intent to maintain the flora and fauna on the refuge in a healthy and natural combination...”

“The Service will emphasize protection of existing fish and wildlife populations and habitats, and restoration of endangered and other species to natural levels. Fish and wildlife management will focus on monitoring and on eradication of introduced wildlife.”

Other

- In fall of 2020, the US Department of Interior (DOI) released a draft Invasive Species Strategic Plan, which outlined several goals. The second major goal outlines is to: ‘cost-effectively prevent the introduction and spread of invasive species into and within the United States’. This biosecurity plan developed by the Alaska Maritime National Wildlife Refuge directly addresses this goal by outlining protocols, educational materials, and communications strategies to serve as tools to prevent the spread of invasive species throughout the geographically large Refuge.

PLAN OBJECTIVES

The Refuge has two primary objectives for the Biosecurity Plan:

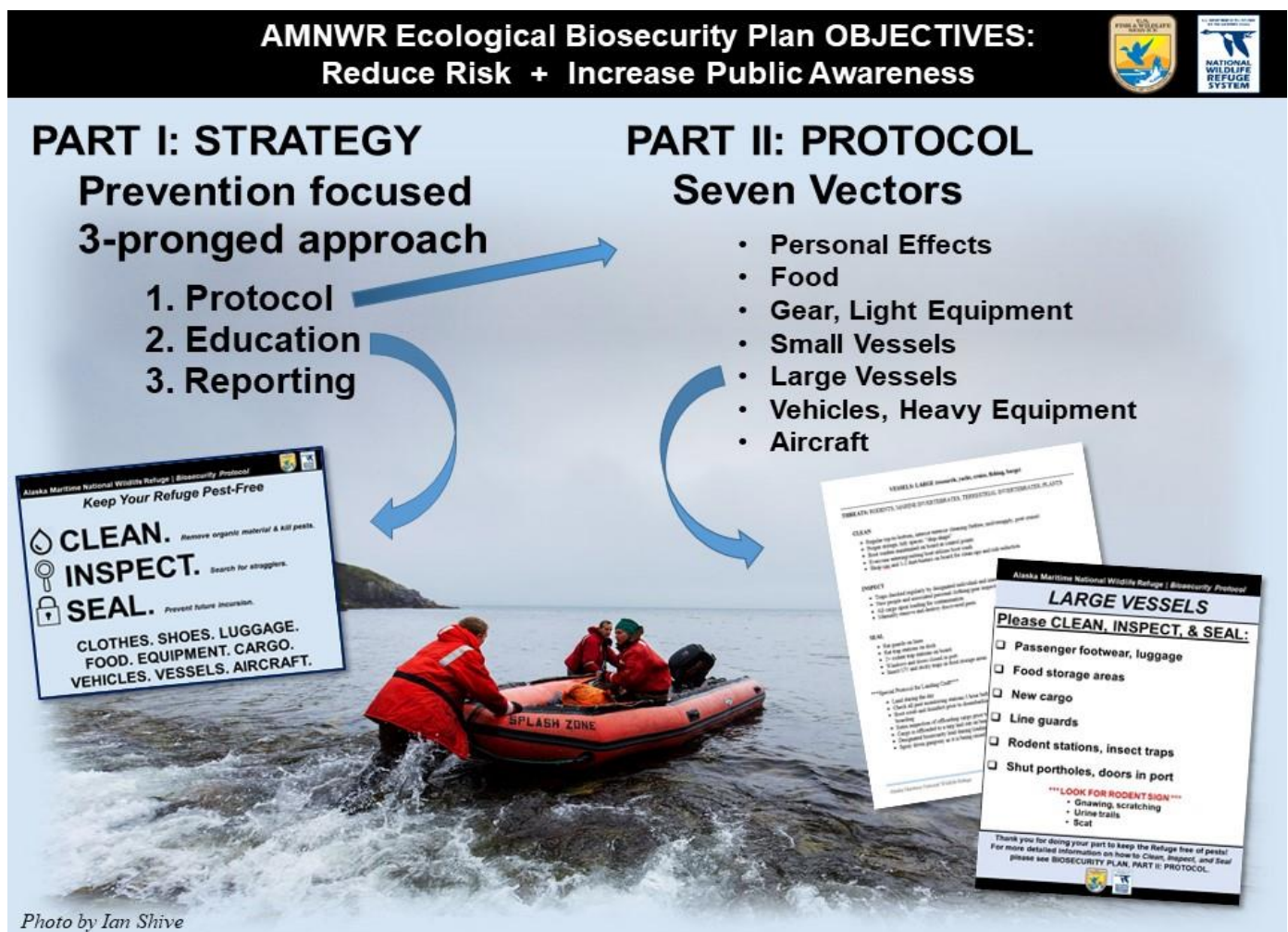
- 1) Proactively reduce risk by implementing defined Best Management Practices for permitted activities on the Refuge.
- 2) Increase public awareness of invasive species risk to the Refuge through education.

To address these objectives, the Biosecurity Plan has two parts.

Part I of the plan is the strategy. The strategy is devoted to prevention and uses a three-pronged approach: risk-reduction protocol, education, and reporting.

Part II of the plan elaborates upon the risk-reduction protocol, and contains guidelines for each anticipated vector of invasive species to the Refuge. Double-sided flyers comprising detailed protocols on one side and a checklist on the other can be printed out and provided for each relevant vector, depending upon the logistics of a specific visit. Each protocol is patterned after the Core Best Management Practice for consistency and ease of implementation.

Additional detail can be found in Appendices 1-6. These appendices include lists of known invasive species from the Refuge, printable diagrams, and best practices for various Refuge activities.



BIOSECURITY PLAN, PART I: STRATEGY

Welcome to Part I of the Biosecurity Plan for the Alaska Maritime National Wildlife Refuge. This section of the plan describes the Refuge's strategy for preventing the introduction and spread of non-native species to Refuge lands. The strategy uses a three-pronged approach to prevention: risk-reduction protocol, education, and reporting. Each prong is detailed below, followed by a brief discussion of the limitations of this plan.

Special Note: Plan Ahead and Prepare

Biosecurity is additional, thankless work. Proper implementation of this strategy requires planning and patience. Extra time should be budgeted into every plan and itinerary to reduce stress and ensure the protocols are properly followed. The biosecurity of the Refuge should not be sacrificed because of poor organizational skills, procrastination, or lack of discipline. Biosecurity is secondary to emergencies; a tough day or poor planning does not qualify as an emergency.

RISK-REDUCTION PROTOCOL

The centerpiece of a prevention-focused biosecurity strategy is the risk-reduction protocol. In spite of the intimidating title, the risk-reduction protocol is simply field hygiene: a set of practices that prevents pests from entering the Refuge. The protocol for this Refuge is based on a best management practice that utilizes three simple concepts, in sequence: **Clean, Inspect, and Seal**. Everything that arrives on Refuge land should be *cleaned* to remove organic material and kill pests, *inspected* for remaining hitchhikers and pests, and *sealed* from incursion.

The 'Clean, Inspect, Seal' framework can be easily adapted for a variety of scenarios. Part II of this plan provides a collection of protocols where 'Clean, Inspect, Seal' is applied to seven anticipated vectors of invasive species to the Refuge. The vectors are:

- Personal Effects, Clothing, and Footwear
- Cargo: Food
- Cargo: Gear and Light Equipment
- Small Vessel (e.g. skiff, tender, zodiac, kayak)
- Large Vessel (e.g. research, charter, yacht, cruise, fishing, barge)
- Cargo: Vehicles and Heavy Equipment
- Aircraft (including UAVs)

To follow the risk-reduction protocol, Refuge visitors must select the vectors that apply to their circumstances and follow the protocols specific to each vector. The protocols are provided in Part II of this plan.

Areas of Special Value

All Refuge lands are important resources for the American people. Conservation of the Refuge's natural resources depends on correct, consistent implementation of this biosecurity plan. However, some regions of the Refuge have been designated as Areas of Special Value for their unique biological or geological attributes. These Areas of Special Value might require extra biosecurity protocols in addition to the standard suite of protocols. The additional protocols will be assigned per the discretion of the Refuge Manager on a case-by-case basis.

EDUCATION

Timely education of Refuge employees, visitors, and the general public is the first line of defense against a biosecurity breach and is a priority measure in non-native species management. We developed a communications strategy in coordination with the Refuge Visitor Services Manager to meet our education objectives. In our communications strategy, education messages and delivery modes have been tailored to specific key audiences which include: Refuge staff and volunteers, construction/cleanup crews, scientific partners, cruise ships, small boat tour operators, tribal partners, commercial fishing vessels, and the general public. This strategy is summarized in a table in Appendix 2. Implementation of the strategy will require sustained coordinated efforts of the Refuge Visitor Services Manager, Assistant Refuge Manager, and Refuge employees.

The communication strategy also strives to be consistent with the Alaska Interagency and Organization Invasive Species Communications Framework (2018), which proposed the following vision statement and slogan.

Vision: Alaska residents, visitors and stakeholders are informed, inspired, and motivated to play an active role keeping Alaska wild and free of invasive species.

Shared Slogan: Alaska Wild and Free of Invasive Species

Briefings

Face-to-face interaction is probably the most effective biosecurity education tactic (Kennedy and Broome 2019). People are more likely to listen than they are to read, and accountability is immediate. Briefings establish expectations and demonstrate protocols, as well as cultivate a culture where biosecurity is the norm.

Briefings should be delivered by a person in an authoritative position (e.g. the Assistant Refuge Manager, the captain/mate of the *Tiglax*, or the cruise/project leader).

Appendix 3 contains the script to accompany the *Tiglax* orientation for all new passengers.

REPORTING

Reporting biosecurity concerns and breaches is the final prong in this prevention strategy. Reports create credible records that are the foundation of response decision making. In addition, reports help managers to measure the effectiveness of this plan. Lastly, they hold employees, visitors, contractors, and permittees accountable for their actions. Reporting should happen on two time scales: real-time or *fast* (i.e. immediately after hitchhikers and pests are observed or intercepted) and annually or *slow* (i.e. during project conclusion and wrap-up). Fast reports happen verbally, through face-to-face interaction, a phone call or email, within minutes to hours of the incident. Slow reports are more formal, are written, and are completed within days to months of the incident and additionally share the data with the appropriate venue.

Reporting Procedure: Fast

1. When a suspected or positively identified hitchhiker or pest is detected alive, it should be captured (or uprooted), killed, and saved for identification whenever possible. If capture/uprooting is not possible, try to document evidence of its presence with scat samples, photographs, and notes.
2. Provide key information:
 - Who** made the detection (include contact information),
 - What** was detected (species or description, and if it is dead, alive, at large, unknown),
 - Where** was it detected (geographical unit, island or site name, and GPS coordinates, if possible),
 - When** was it detected (date and time), and

List of Evidence (describe samples or specimens taken and where they are stored, paste photographs directly in report).

3. CALL BOTH the Refuge Manager AND the Alaska Invasive Species Hotline with your information.

Refuge Manager: 907-235-6546

Alaska Invasive Species Hotline: 1-877-INVASIV (468-2748)

Reporting Procedure: Slow

1. All of the above, *and*
2. The information needs to be compiled into a written report by the Refuge Manager. The written report should be a word document saved with a name using the following structure:

UNITNAME_TYPE_DDMmmYYYY.doc

UNITNAME options: CHU (Chukchi), BER (Bering), ALE (Aleutian), AKP (Alaska Peninsula), GAK (Gulf of Alaska).

TYPE options: PLANT, ANIMAL, OTHER

DDMmmYYYY: The date should be the 2-digit day, 3-letter month, 4-digit year of detection, NOT the date of filing.

Example report file name: AKP_ANIMAL_23Jun2019.doc

Save the report by year-class in a designated biosecurity folder in the common drive.

LIMITATIONS OF PLAN

Lack of Enforcement Power

The remoteness and scale of the Refuge is both a strength and impediment for biosecurity. On the one hand, the sheer cost and logistics of accessing most of the Refuge dramatically restricts most visitation (and associated biosecurity risk). The drawback of remoteness is that it is impossible to monitor all visitation across the Refuge and to enforce this plan and its protocols. Without enforcement, biosecurity becomes the personal responsibility of every visitor. Implementation of the plan must be self-policed.

Multicellular Bias

In addition, this plan is biased toward multicellular, visible organisms. Though some of the sanitation protocols in Part II will inherently help to reduce the risk of pathogen introduction, this plan does not explicitly address preventative measures for disease outbreak, epidemics, or bioterrorism.

Prevention Focused

The strategy of this plan is entirely directed toward preventative measures. This was a deliberate choice. As a result, this version of the plan does not detail response or eradication actions for non-native species beyond reporting observations to the appropriate authorities.

For response/eradication plans, see:

Wildlife and People at Risk: A Plan to Keep Rats out of Alaska. Ellen Fritts, 2007

The USFWS Rapid Response Plan for Invasive Rodents in Alaska, 2020

A USFWS Rapid Response Plan for Invasive Terrestrial and Emergent Plant in Alaska, 2020

Remains to Be Tested

This is the first version of the Refuge's biosecurity plan. The intention for this plan is for it to be a living document that will continue to be refined and assessed over time. 2020 will prove to be an important pilot year for testing the feasibility of the proposed protocols.

Finally, we recognize that there are myriad biosecurity issues that require the gathering of more information in order to make better decisions, and that there are complex scenarios that this version of the plan fails to wholly address. In Appendix 6 we created a repository of issues that have been tabled until they can be better addressed in the event that more data are gathered or a dedicated invasive species biologist is hired.

BIOSECURITY PLAN, PART II: PROTOCOLS

Welcome to Part II of the Biosecurity Plan for the Alaska Maritime National Wildlife Refuge. This section of the plan is the handbook for the risk-reduction protocol. First is a breakdown of the Clean, Inspect, Seal conceptual framework. Next is the ‘menu’ of protocols and associated checklists. There are seven total, one for each anticipated vector of non-native species to the Refuge. Each protocol is patterned after the Clean, Inspect, Seal framework for ease and consistency of implementation. Visitors need to be supplied the vector protocols and checklists that apply to the logistics of their visit during the planning and permitting process, or at the start of the field season. Please use your best professional judgment and common sense when following these protocols. See Appendix 4 for printable diagrams to guide the Clean, Inspect, and Seal procedures outlined in this section.

The Core Practice: CLEAN, INSPECT, and SEAL

The centerpiece of a prevention-focused biosecurity strategy is the risk-reduction protocol. The protocol for this Refuge is based on a conceptual framework that utilizes three simple concepts in sequence: Clean, Inspect, and Seal.

Everything that arrives on Refuge land should be
CLEANED to remove organic material and kill pests,
INSPECTED for hitchhikers and pests, and
SEALED from incursion.

WHAT do I CLEAN, INSPECT, SEAL?

- Packing, staging, and storage **AREAS**: *homes, warehouses, ship holds, camps*
- Containers and transport **VESSELS**: *luggage, totes, ships, boats, aircraft*
- **ITEMS**: *personal effects, gear, equipment, food, samples, other cargo*

WHEN do I CLEAN, INSPECT, SEAL?

- Before departing for Refuge lands
- During a resupply
- Before departing Refuge lands

WHERE do I CLEAN, INSPECT, SEAL?

- At home
- At warehouses (Homer, Adak, Sitka, Pribilofs)
- Aboard *Tiglax* or other similar vessel
- In camp

HOW to CLEAN:

1. Remove organic material
 - Vacuum dry surfaces, interiors
 - Pressure wash tough exteriors with large surface areas (620 kPa [90 psi], preferably 60°C [140°F] potable water)
 - Scrub tough exteriors with smaller surface areas (e.g. boots with a stiff brush)
 - Air blast crevices and hard-to-reach areas
2. Wash/disinfect **Submersible** items using one of the following options:
 - GENERAL: Laundry detergent or dish soap
 - ANIMAL SAMPLING EQUIPMENT requires DISINFECTION: 20ppm (4ml/L) liquid chlorine bleach bath for 10 minutes **OR** 1oz Quaternary Ammonium Chloride (Quat)/gal waterWash/disinfect **Non-Submersible** items using one of the following options:
 - GENERAL: wipe down with warm damp cloth
 - ANIMAL SAMPLING EQUIPMENT: 20ppm (4ml/L) liquid chlorine bleach spray (rinse after 10 mins) **OR** spray/wipe with Quat solution **OR** Clorox Wipes
3. Thorough drying/desiccation, preferably high-heat or UV exposure

HOW to INSPECT:

1. Create prime conditions so inspections are effective: excellent lighting (preferably daylight), short timeframe
2. Complete a thorough visual and tactile examination for hitchhikers, dirt, and debris (THOROUGH means unfolding tents and weatherports, checking inside outboard cowlings and weatherport poles, opening any container that has not previously been inspected and sealed against incursion)
3. Manually remove and destroy located hitchhikers, dirt, and debris

GOAL: NO dirt or debris
NO hair, fur, feathers
NO animals
NO insects and arthropods
NO seeds, plant, fruit, vegetable material
NO feces
NO other biologically active: yeast, fungus,
mold, mildew, pathogens, bacteria

HOW to SEAL:

- Area, storage/transport vessel, and/or item unit is COMPLETELY CLOSED to pests
- Area, storage/transport vessel, and/or item unit is protected from invasion when out of sight (baited traps, sticky traps, motion triggered cameras, UV bug zappers)
- Create barriers to invasion, such as keeping “like with like” (e.g. designate gear for specific locations and store separately), rat guards on ship lines, ultrasonic deterrents



Keep Your Refuge Pest-Free



CLEAN.

Remove organic material & kill pests.



INSPECT.

Search for stragglers.



SEAL.

Prevent future incursion.

**CLOTHES. SHOES. LUGGAGE.
FOOD. EQUIPMENT. CARGO.
VEHICLES. VESSELS. AIRCRAFT.**

CLOTHING, FOOTWEAR, PERSONAL EFFECTS

THREATS: PLANTS, TERRESTRIAL INVERTEBRATES, RODENTS, SOIL MICROBES

CLEAN

- *The area where you pack:* sweep/vacuum/mop, lay down clean sheet or tarp.
- *The luggage/container you are packing:* vacuum and/or scrub, wash. We **strongly recommend** packing items in plastic or rubber rodent-proof totes or using slick, impervious luggage made of nylon or laminated fabrics.
- *The items being packed:* clothes, shoes, and personal items; use hot water and soap. Use stiff brush on shoe soles. Remove insoles and vacuum inside all shoes.

INSPECT

- Examine the cleaned packing area and luggage for remaining hitchhikers or pests that might re-invade (mosquitoes, earwigs, flies, cockroaches, etc.). Manually remove or clean again.
- Handle every individual item you are packing and check for hitchhikers. **Danger zones:** socks, cuffs, shoe tongues, under insoles, pockets, and ALL VELCRO. If hitchhikers cannot be removed, the item should not come to the Refuge.
- Pack in daylight to increase detection confidence and reduce crepuscular and nocturnal incursions
- Pack in one go so you only have to inspect once.

SEAL

- Pack items in totes or luggage made of nylon or laminated fabrics (such as dry bags) whenever possible.
- Completely close the receptacle whenever you leave the packing area and when you are finished packing.

Store in an area with pest control: UV insect killers, sticky traps, rat and mouse traps.

Special protocol for mustang suits, float coats, and life vests

- Wash and dry used mustang suits and life vests annually.
- Once ashore, remove mustang suits/float coats below the high tide line and stuff into a dry bag for storage on shore.
- Check mustang suit and life vest Velcro for seeds and remove before visiting another site using forceps.

NOTE: FELT SOLED BOOTS ARE BANNED IN ALASKA, AND ARE NOT PERMITTED ON THE REFUGE (photos by Pat Lurcock)



PERSONAL EFFECTS

Please CLEAN, INSPECT, & SEAL:

- ☐ **Packing area**
- ☐ **Luggage**
- ☐ **Backpacks**
- ☐ **Gear bags, totes [camera, binoculars]**
- ☐ **Clothing [esp. socks, pockets, cuffs, velcro]**
- ☐ **Footwear [NO FELT SOLES]**
- ☐ **Bedding, sleeping bags**

**Thank you for doing your part to keep the Refuge free of pests!
For more detailed information on how to *Clean, Inspect, and Seal*
please see BIOSECURITY PLAN, PART II: PROTOCOL.**



CARGO: FOOD

THREATS: RODENTS, PLANTS, TERRESTRIAL INVERTEBRATES, SOIL MICROBES

CLEAN

- Disinfect and dry all food storage containers and coolers
- Keep food storage areas clean and tidy (weekly)
- Wash produce that has visible dirt. NO leafy clusters that trap dirt and invertebrates
- NO produce from personal gardens or farmers market
- Store-purchased eggs only
- NO raw eggshells disposed on beach; bake or bleach before disposal
- Ban of gardens and food/plant cultivation at field camps, NO SPROUTS

INSPECT

- Keep food storage areas well lit
- Check all food items for infestation during packing AND upon arrival to final destination
- Perform inspection in designated, secure containment area, such as cabin/kitchen/tent
- Inspect food items arriving directly to the ship as soon as possible after being brought aboard. Examine individual boxes, plastic bags, etc. for evidence of rodent incursion and for the presence of live or dead insects; cast “skins,” or pinholes made when pests enter or exit the packaging. See the table from the US Navy Pest Control Manual for suggestions for the number of items to be inspected for bulk orders
- Check insect and rat traps every week

Recommended sample sizes to detect infestations
(From the US Navy Pest Control Manual)

Lot size (Primary container)	Sample size
2 to 15	2
16 to 50	3
51 to 150	5
151 to 500	8
501 to 3200	13
3201 to 35000	20
35001 to 500000	32
500001 and over	50

SEAL

- Produce should be stored in non-cardboard, rodent/pest-proof secondary containers to the greatest extent possible. This is especially true for produce that will be going out to field locations
- Store opened items, such as bulk orders of grains, in rodent-proof containers
- Baited rat traps inside and outside food preparation and storage areas, serviced regularly
- Sticky insect traps and rodent traps in food preparation and storage areas; install UV zap traps where feasible

CONTAINMENT NOTE: Bringing any fresh food to the Refuge increases the risk of introducing non-native species. For example, in the Aleutians, potatoes and other root vegetables have been grown successfully, and apple trees have sprouted from planted seeds. For this reason it is important to properly dispose of food scraps.

- Anything capable of sprouting or rooting should not be buried or burned on site but placed in sealed trash to be removed from the Refuge
- Ground food waste (ground to 1” or smaller) must be discharged 3 nautical miles or more from land outside of arctic waters. In arctic waters, ground food waste must be discharged 12 nautical miles from shore. Unground food waste must be discharged 12 nautical miles from shore outside of arctic waters. Discharge of unground food waste is prohibited in arctic waters, as per the International Maritime Organization MARPOL Annex V Resolution (2018).
- Kill insects found in infested cardboard or food items by freezing at or below -20°C for at least one week prior to disposal. If possible, include live pest insect in a vial as an indicator.

FOOD

Please CLEAN, INSPECT, & SEAL:

- ☐ Staging area
- ☐ Storage boxes, totes
- ☐ Produce, eggs [no dirt, bugs, feces]
- ☐ Rodent stations, insect traps
- ☐ NO SPROUTS, PLANTS, GARDENS
- ☐ Remove all viable food scraps from the Refuge [seeds, roots, basal stems]

*** LOOK FOR RODENT SIGN ***

- Gnawing, scratching
- Urine trails
- Scat

Thank you for doing your part to keep the Refuge free of pests!
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please see BIOSECURITY PLAN, PART II: PROTOCOL.



CARGO: GEAR, LIGHT EQUIPMENT

THREATS: RODENTS, PLANTS, INVERTEBRATES, SOIL MICROBES, ZOO NOTIC PATHOGENS

CLEAN

- Vacuum/sweep/mop packing area and receiving area
- Wash and dry all equipment containers
- Pay **special attention** to equipment that touches soil, vegetation, animals
- **ALL EQUIPMENT THAT CONTACTS ANIMALS:** Soak submersible equipment in disinfectant solution or wipe non-submersible with disinfectant (see: HOW TO CLEAN, above)
- **ALL EQUIPMENT THAT CONTACTS DIRT:**
 1. Remove dirt and debris by scrubbing/rinsing; then
 2. Treat with proper disinfectant protocol (see: HOW TO CLEAN, above)
- *Caveat:* Sensitive scientific equipment and climbing equipment should be cleaned per manufacturer's instructions

INSPECT

- Actively search and destroy hitchhikers, dirt, and debris from all items after cleaning

SEAL

- Close all containers after they are packed
- Do not leave containers open and unattended
- Keep warehouse/packing area doors and windows closed while packing is in progress
- Maintain rat and insect traps in the packing area

GEAR & LIGHT EQUIPMENT

Please CLEAN, INSPECT, & SEAL:

- ☐ Staging area
- ☐ Backpacks, drybags, totes
- ☐ Scientific sampling equipment
- ☐ Camping equipment
- ☐ Filming, camera equipment
- ☐ Hand tools
- ☐ Building supplies [*no raw wood*]
- ☐ Fuel cans, firewood [*local source only*]
- ☐ Brailer bags

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VESSELS: SMALL (tenders, skiffs, zodiacs, kayaks)

THREATS: PLANTS, TERRESTRIAL & AQUATIC INVERTEBRATES, SOIL MICROBES

CLEAN

- Vacuum and rinse vessel before leaving warehouse or storage area
- Rinse the anchor clean of debris
- Require boot wash before passengers step inside
- Ensure a very thorough cleaning of any items that were stored outdoors during the off season, as these have the highest risk of harboring non-native animal or plant species
- Clean items prior to loading onto a ship, and also prior to off season storage

INSPECT

- Manually remove and discard any potential sources of contamination

SEAL

- Thorough drying/desiccation is best protection from aquatic invasive species
- Store in pest-proofed area whenever possible
- Ensure that any items stored outdoors during off season are covered tightly with tarps to prevent incursion of seeds or other non-native pest species

SMALL VESSELS

Please CLEAN, INSPECT, & SEAL:

- ☐ **Vessel interior**
- ☐ **Vessel exterior**
- ☐ **Rudder**
- ☐ **Motor**
- ☐ **Anchor**
- ☐ **Paddles, oars**
- ☐ **Storage area**

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THREATS: RODENTS, MARINE INVERTEBRATES, TERRESTRIAL INVERTEBRATES, PLANTS

CLEAN

- Regular top-to-bottom, interior/exterior cleaning (before, mid/resupply, post cruise)
- Proper storage, tidy spaces: “ship-shape”
- Boot washes maintained on board at control points
- Everyone entering/exiting boat utilizes boot wash
- Shop-vac and 1-2 dust-busters on board for clean-ups and risk reduction
- Ensure items not originating from secured locations are cleaned prior to loading
- Brailer bags stored onboard should be cleaned annually

INSPECT

- Passengers should embark and disembark at designated control points to increase efficiency of moving through cleaning stations and to facilitate inspection of goods
- New people and associated personal clothing/gear inspected and cleaned immediately upon arrival
- Traps checked regularly by designated individual and immediately before and after port
- Check all cargo upon loading for contamination
- Manually remove and destroy discovered pests

SEAL

- Rat guards on lines, ALWAYS use when in ports with known infestations
- Rat trap stations on dock
- 2+ rodent trap stations on board
 - Place traps every 20-25 feet if mice or rats are present, every 40 feet if there is no clear evidence of mice or rats, especially around interior access points and hatches
- Windows and doors closed in port
- Insect UV and sticky traps in food storage areas

*****Special Protocol for Landing Craft*****

- Land during the day
- Check all pest monitoring stations 1 hour before landing
- Boot scrub and disinfect prior to disembarking and for any loading passengers immediately upon boarding
- Extra inspection of offloading cargo prior to disembarking
- Cargo is offloaded to a tarp laid out on beach (barrier)
- Designated biosecurity lead during loading/offloading: sole duty is to watch for pests/hitchhikers
- Spray down gangway as it is being raised

LARGE VESSELS

Please CLEAN, INSPECT, & SEAL:

- ☐ Passenger footwear, luggage
- ☐ Food storage areas
- ☐ New cargo
- ☐ Line guards
- ☐ Rodent stations, insect traps
- ☐ Shut portholes, doors in port

***** LOOK FOR RODENT SIGN *****

- Gnawing, scratching
- Urine trails
- Scat

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THREATS: PLANTS, SOIL MICROBES, TERRESTRIAL INVERTEBRATES

CLEAN

- Before transport: follow vehicle cleaning checklist for specific vehicle type (App. 5)
- Wash on an impervious surface
- Pressure wash (620 kPa [90 psi]) *or* manually scrub entire exterior
- Spray surfaces that have the most contact with dirt, vegetation, and water with a Quat solution OR 60°C (140°F) water for 15+ seconds (non-porous) or 5+ minutes (porous)
- Vacuum and fumigate interior
- Clean again at loading site if re-contaminated en route

INSPECT

- Immediately before loading on ship or aircraft
- Immediately before deployment on refuge

SEAL

- Keep vehicle windows closed during transport
- Store vehicle in pest-proofed area
- Install pest traps onboard the vehicle
- Use plastic wheel chocks rather than wood

VEHICLES & HEAVY EQUIPMENT

Please CLEAN, INSPECT, & SEAL:

- ☐ Staging area
- ☐ Interior, cabin
- ☐ Exterior
- ☐ Undercarriage
- ☐ Wheels, tracks, buckets
- ☐ Under the hood

See APPENDIX 5 for more details

Thank you for doing your part to keep the Refuge free of pests!
For more detailed information on how to *Clean, Inspect, and Seal*
please see BIOSECURITY PLAN, PART II: PROTOCOL.



AIRCRAFT

THREATS: RODENTS, PLANTS, TERRESTRIAL INVERTEBRATES

CLEAN

- Vacuum, clean and disinfect: cabin area, cockpit, wheels, wheel wells, skid/runner bars, under deck plates, panels, flap wells
- Prior to boarding and between flights

INSPECT

- Pack in daylight to better see pests and prevent incursions
- Prior to take-off, inspect and remove hitchhikers from interior and exterior of aircraft
- Require last minute self-check of passengers and crew prior to boarding for hitchhikers on clothing and carry-ons

SEAL

- Keep windows and doors closed whenever possible
- Boot brushes and disinfection prior to boarding

*** *Special Precautions for Floatplanes****

THREATS: AQUATIC PLANTS AND INVERTEBRATES

- Scrub floats, rinse with high-pressure hot water
- *Before take-off*: pump float water back into original body
- *After water take-off*: raise and lower rudders several times
- Dry for 5 days or more between water bodies

AIRCRAFT & UAV

Please CLEAN, INSPECT, & SEAL:

- ☐ Cabin
- ☐ Cockpit
- ☐ Wheels, wheel wells
- ☐ Skid, runner bars, drone legs
- ☐ Under deck plates
- ☐ Panels
- ☐ Flap wells
- ☐ Floats, float water [*floatplanes only*]
- ☐ Rudders [*floatplanes only*]

Thank you for doing your part to keep the Refuge free of pests!
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please see BIOSECURITY PLAN, PART II: PROTOCOL.



APPENDIX 1. Non-Native Animal and Plant Species of Alaska Maritime National Wildlife Refuge

Table 1. Non-native animal and plant species documented on Alaska Maritime National Wildlife Refuge lands. For plants, the source indicates the collector and year of collection; this information was gathered from Bella 2014 and Gravley 2018. For animals, cited sources can be found in References, except for two personal email communications with Derek Sikes (12 Aug 2019) and Lisa Spitler (27 Aug 2019).

SITE	TYPE	COMMON NAME	SCIENTIFIC NAME	SOURCE
Adak	animal	caribou	<i>Rangifer tarandus</i>	Gotthardt et al. 2015
		feral cat	<i>Felis catus</i>	Gotthardt et al. 2015
		Norway rat	<i>Rattus norvegicus</i>	Gotthardt et al. 2015
	plant	big chickweed	<i>Cerastium fontanum ssp. vulgare</i>	Walker 2012
		cocksfoot	<i>Dactylis glomerata</i>	Gravley 2017
		common dandelion	<i>Taraxacum officinale</i>	Gravley 2017
		common juniper	<i>Juniperus communis</i>	Gravley 2017
		common plantain	<i>Plantago major</i>	Gravley 2017
		common timothy	<i>Phleum pratense</i>	Gravley 2017
		creeping buttercup	<i>Ranunculus repens</i>	Gravley 2017
		hairy cats ear	<i>Hypochaeris radicata</i>	Gravley 2017
		lawndaisy	<i>Bellis perennis</i>	Gravley 2017
		orange hawkweed	<i>Hieracium aurantiacum</i>	Gravley 2017
		oxeye daisy	<i>Leucanthemum vulgare</i>	Gravley 2017
		perennial ryegrass	<i>Lolium perenne</i>	Gravley 2017
		poison hemlock	<i>Conium maculatum</i>	Gravley 2017
		red clover	<i>Trifolium pratense</i>	Gravley 2017
		salmonberry	<i>Rubus spectabilis</i>	Gravley 2017
		sheep sorrel	<i>Rumex acetosella</i>	Gravley 2017
		Sitka spruce	<i>Picea sitchensis</i>	Gravley 2017
		sweet vernalgrass	<i>Anthoxanthum odoratum</i>	Gravley 2017
		velvetgrass	<i>Holcus lanatus</i>	Gravley 2017
		white clover	<i>Trifolium repens</i>	Gravley 2017
Afognak	animal	ground squirrel	<i>Spermophilus parryii</i>	Bailey 1993
Aiktak	plant	annual bluegrass	<i>Poa annua</i>	Bella 2014
		common chickweed	<i>Stellaria media</i>	Bella 2014
Akun	animal	cattle	<i>Bos taurus</i>	Gotthardt et al. 2015
		horse	<i>Equus caballus</i>	Gotthardt et al. 2015
	plant	big chickweed	<i>Cerastium fontanum ssp. vulgare</i>	Bella 2014
		common chickweed	<i>Stellaria media</i>	Bella 2014
		Kentucky bluegrass	<i>Poa pratensis</i>	Bella 2014
Akutan	animal	thymeleaf speedwell	<i>Veronica serpyllifolia</i>	Bella 2014
		cattle	<i>Bos taurus</i>	Gotthardt et al. 2015
		elk	<i>Cervus canadensis</i>	Gotthardt et al. 2015
		horse	<i>Equus caballus</i>	Gotthardt et al. 2015
Amaknak	plant	Norway rat	<i>Rattus norvegicus</i>	Gotthardt et al. 2015
		sheep sorrel	<i>Rumex acetosella</i>	Fries 1977
Amchitka	animal	bird vetch	<i>Vicia cracca</i>	Filut 1984
		Norway rat	<i>Rattus norvegicus</i>	Gotthardt et al. 2015
	plant	annual bluegrass	<i>Poa annua</i>	Reich 1962

Amchitka (cont'd)	plant	common plantain lawndaisy sheep sorrel Sitka spruce white clover	<i>Plantago major</i> <i>Bellis perennis</i> <i>Rumex acetosella</i> <i>Picea sitchensis</i> <i>Trifolium repens</i>	Gravley 2018 Gravley 2018 Gravley 2018 Gravley 2018 Gravley 2018
Atka	animal	caribou fox Norway rat	<i>Rangifer tarandus</i> <i>Vulpes vulpes</i> <i>Rattus norvegicus</i>	Gotthardt et al. 2015 Gotthardt et al. 2015 Gotthardt et al. 2015
Attu	animal	Norway rat	<i>Rattus norvegicus</i>	Gotthardt et al. 2015
	plant	annual bluegrass bog marshcress hairy cats ear Kentucky bluegrass oval leaf blueberry rape mustard sheep sorrel Sitka spruce thymeleaf speedwell	<i>Poa annua</i> <i>Rorippa palustris</i> <i>Hypochaeris radicata</i> <i>Poa pratensis</i> <i>Vaccinium ovalifolium</i> <i>Brassica rapa</i> <i>Rumex acetosella</i> <i>Picea sitchensis</i> <i>Veronica serpyllifolia</i>	Parker 1999 Parker 1999 Parker 1999 Parker 1999 Talbot 2000 Hardy 1945 Talbot 2000 Talbot 1988 Talbot 2000
Big Koniuji	animal	ground squirrel	<i>Spermophilus parryii</i>	Bailey 1993
Carlisle	plant	big chickweed	<i>Cerastium fontanum ssp. vulgare</i>	Talbot 2013
		salmonberry	<i>Rubus spectabilis</i>	Talbot 2013
Chankliut	animal	ground squirrel vole	<i>Spermophilus parryii</i> <i>Microtus spp.</i>	Bailey 1993 Cook et al. 2010
Chirikof	plant	annual bluegrass	<i>Poa annua</i>	Bella 2014
		big chickweed	<i>Cerastium fontanum ssp. vulgare</i>	Bella 2014
		birdeye pearlwort	<i>Sagina procumbens</i>	Bella 2014
		California brome	<i>Bromus carinatus</i>	Talbot 2013
		common chickweed	<i>Stellaria media</i>	Bella 2014
		common dandelion	<i>Taraxacum officinale</i>	Bella 2014
		common plantain	<i>Plantago major</i>	Bella 2014
		hairy cats ear	<i>Hypochaeris radicata</i>	Bella 2014
		Kentucky bluegrass	<i>Poa pratensis</i>	Bella 2014
		perennial ryegrass	<i>Lolium perenne</i>	Talbot 2013
		sheep sorrel	<i>Rumex acetosella</i>	Bella 2014
		thymeleaf speedwell	<i>Veronica serpyllifolia</i>	Bella 2014
Chowiet	plant	Sitka spruce	<i>Picea sitchensis</i>	Hatch 1977
Chuginadak	animal	fox	<i>Vulpes vulpes</i>	Gotthardt et al. 2015
East Amatuli	plant	common dandelion	<i>Taraxacum officinale</i>	J. Fulkerson, pers. comm.2020
Great Sitkin	animal	Norway rat	<i>Rattus norvegicus</i>	Gotthardt et al. 2015
Hagemeister	animal	caribou	<i>Rangifer tarandus</i>	Gotthardt et al. 2015
Kagalaska	animal	caribou	<i>Rangifer tarandus</i>	Gotthardt et al. 2015
		Norway rat	<i>Rattus norvegicus</i>	Gotthardt et al. 2015
Kagamil	plant	salmonberry	<i>Rubus spectabilis</i>	Talbot 2013
Kaligagan	plant	annual bluegrass	<i>Poa annua</i>	Talbot 2002
Kasatochi	animal	painted lady butterfly	<i>Vanessa cardui</i>	Spitler 2019
Kateekuk	animal	ground squirrel	<i>Spermophilus parryii</i>	Cook et al. 2010
Kavalga	animal	ground squirrel	<i>Spermophilus parryii</i>	Gotthardt et al. 2015
Kiliktagik	animal	ground squirrel	<i>Spermophilus parryii</i>	Cook et al. 2010
Kiska	animal	Norway rat	<i>Rattus norvegicus</i>	Gotthardt et al. 2015
Little Koniuiji	animal	ground squirrel	<i>Spermophilus parryii</i>	Cook et al. 2010

Popof	animal	snowshoe hare	<i>Lepus americanus</i>	Bailey 1993
Puffin Island	plant	common dandelion	<i>Taraxacum officinale</i>	Brown, B.; Pyle B. in AKEPIC
Samalga	animal	fox	<i>Vulpes vulpes</i>	Gotthardt et al. 2015
Sedanka	animal	Norway rat	<i>Rattus norvegicus</i>	Gotthardt et al. 2015
Shemya	animal	deer mouse	<i>Peromyscus</i>	Gotthardt et al. 2015
		fox	<i>Vulpes vulpes</i>	Gotthardt et al. 2015
		roof rat	<i>Rattus rattus</i>	Gotthardt et al. 2015
Simeonof	plant	big chickweed	<i>Cerastium fontanum ssp. vulgare</i>	Talbot 2014
		birdeye pearlwort	<i>Sagina procumbens</i>	Talbot 1995
		common chickweed	<i>Stellaria media</i>	Bella 2014
		common mouse-ear chickweed	<i>Cerastium fontanum</i> Baumg.	Talbot 1995
		common plantain	<i>Plantago major</i>	Bella 2014
		common tansy	<i>Tanacetum vulgare</i>	Talbot 2014
		common timothy	<i>Phleum pratense</i>	Talbot 2014
		creeping bentgrass	<i>Agrostis stolonifera</i>	Talbot 2014
		garden rhubarb	<i>Rheum rhabarbarum</i>	Bella 2014
		Kentucky bluegrass	<i>Poa pratensis</i>	Bella 2014
		oxeye daisy	<i>Leucanthemum vulgare</i>	Bella 2014
		rough bluegrass	<i>Poa trivialis</i>	Talbot 1995
		rugosa rose	<i>Rosa rugosa</i>	Bella 2014
		sheep sorrel	<i>Rumex acetosella</i>	Bella 2014
		sticky chickweed	<i>Cerastium glomeratum</i> Thuill.	Talbot 1995
		strawberry	<i>Fragaria virginiana</i>	Bella 2014
		sweet vernalgrass	<i>Anthoxanthum odoratum</i>	Talbot 2014
		velvetgrass	<i>Holcus lanatus</i>	Bella 2014
St. George	animal	caribou	<i>Rangifer tarandus</i>	Gotthardt et al. 2015
		earthworm	<i>Dendrobaena octaedra</i>	Sikes 2019
		German cockroach	<i>Blatella germanica</i>	Sikes 2019
St. Paul	animal	aphid	<i>Pterocomma populem</i>	Sikes 2019
		brown house moth	<i>Hofmannophila pseudospretella</i>	Sikes 2019
		caribou	<i>Rangifer tarandus</i>	Gotthardt et al. 2015
		house mouse	<i>Mus musculus</i>	Gotthardt et al. 2015
Sud	animal	hoary marmot	<i>Marmota caligata</i>	Bailey 1993
Tangik	animal	European rabbit	<i>Oryctolagus cuniculus</i>	Gotthardt et al. 2015
Umnak	animal	bison	<i>Bison bison</i>	Gotthardt et al. 2015
		caribou	<i>Rangifer tarandus</i>	Gotthardt et al. 2015
		cattle	<i>Bos taurus</i>	Gotthardt et al. 2015
		ground squirrel	<i>Spermophilus parryii</i>	Gotthardt et al. 2015
		horse	<i>Equus caballus</i>	Gotthardt et al. 2015
		sheep	<i>Ovis aries</i>	Gotthardt et al. 2015
	plant	annual bluegrass	<i>Poa annua</i>	Barker 1993
		rough bluegrass	<i>Poa trivialis</i>	Barker 1993
		Sitka spruce	<i>Picea sitchensis</i>	Barker 1993
Unalaska	animal	caribou	<i>Rangifer tarandus</i>	Gotthardt et al. 2015
		cattle	<i>Bos taurus</i>	Gotthardt et al. 2015
		ground squirrel	<i>Spermophilus parryii</i>	Gotthardt et al. 2015
		horse	<i>Equus caballus</i>	Gotthardt et al. 2015
		house mouse	<i>Mus musculus</i>	Gotthardt et al. 2015
		Norway rat	<i>Rattus norvegicus</i>	Gotthardt et al. 2015

		sheep	<i>Ovis aries</i>	Gotthardt et al. 2015
Unalaska (cont'd)	plant	annual bluegrass	<i>Poa annua</i>	McCartney 1986
		birdeye pearlwort	<i>Sagina procumbens</i>	Golodoff 1995
		bristly sheepburr	<i>Lappula squarrosa</i>	Parker 1996
		cocksfoot	<i>Dactylis glomerata</i>	McCartney 1986
		common dandelion	<i>Taraxacum officinale</i>	McCartney 1986
		common mouse-ear chickweed	<i>Cerastium fontanum</i> Baumg.	Golodoff 1995
		common timothy	<i>Phleum pratense</i>	Eyerdam 1932
		creeping buttercup	<i>Ranunculus repens</i>	Golodoff 1995
		hairy lady's mantle	<i>Alchemilla monticola</i> Opiz.	Zika 2014
		lawndaisy	<i>Bellis perennis</i>	McCartney 1990
		narrowleaf hawksbeard	<i>Crepis tectorum</i>	Parker 1996
		red clover	<i>Trifolium pratense</i>	Parker 1994
		rough bluegrass	<i>Poa trivialis</i>	McCartney 1989
		sheep sorrel	<i>Rumex acetosella</i>	Golodoff 1995
		sweet vernalgrass	<i>Anthoxanthum odoratum</i>	Parker 1996
		tall fescue	<i>Schedonorus arudinaceus</i>	McCartney 1986
		tall oatgrass	<i>Arrhenatherum elatius</i>	McCartney 1986
		thymeleaf speedwell	<i>Veronica serpyllifolia</i>	Golodoff 1995
Unalga	animal	fox	<i>Vulpes vulpes</i>	Gotthardt et al. 2015
Unimak	animal	ground squirrel	<i>Spermophilus parryii</i>	Gotthardt et al. 2015
	plant	hairy cats ear	<i>Hypochaeris radicata</i>	Talbot 2011
Village Island	plant	Canada thistle	<i>Cirsium arvense</i>	Brown, B. in AKEPIC
Wosnesenki	plant	big chickweed	<i>Cerastium fonatnum ssp. vulgare</i>	Bella 2014
		common chickweed	<i>Stellaria media</i>	Bella 2014
		common dandelion	<i>Taraxacum officinale</i>	Bella 2014
		common plantain	<i>Plantago major</i>	Bella 2014
		Kentucky bluegrass	<i>Poa pratensis</i>	Bella 2014
		sheep sorrel	<i>Rumex acetosella</i>	Bella 2014
		thymeleaf speedwell	<i>Veronica serpyllifolia</i>	Bella 2014
Administrative Sites				
Homer warehouse	plant	common dandelion	<i>Taraxacum officinale</i>	K. Schake 2020, pers. obs.
		fall dandelion	<i>Leontodon autumnalis</i>	K. Schake 2020, pers. obs.
		common chickweed	<i>Stellaria media</i>	K. Schake 2020, pers. obs.
		pineapple weed	<i>Matricaria discoidea</i>	K. Schake 2020, pers. obs.
		common plantain	<i>Plantago major</i>	K. Schake 2020, pers. obs.
		white clover	<i>Trifolium repens</i>	K. Schake 2020, pers. obs.
		timothy grass	<i>Trifolium repens</i>	K. Schake 2020, pers. obs.
Islands and Oceans Visitor Center	plant	bird vetch	<i>Vicia cracca</i>	K. Schake 2020, pers. obs.

Table 2. Non-native animal and plant species documented in or near Alaska Maritime National Wildlife Refuge submerged lands and waters.

REFUGE UNIT	LOCATION	LOCATION DETAIL	TYPE	COMMON NAME	SCIENTIFIC NAME	REFERENCE
AIU	Dutch Harbor/Unalaska	City Spit Dock, Harbor port, East Point Dock	Animal	Japanese skeleton shrimp	<i>Caprella mutica</i>	Ashton et al. 2008; Fofonoff et al. 2018
BSU	Bristol Bay	No data	Animal	softshell clam	<i>Mya arenaria</i>	Bernard 1979; Carlton 1979; Fofonoff et al. 2018
BSU	Norton Sound	No data	Animal	softshell clam	<i>Mya arenaria</i>	Bernard 1979; Carlton 1979; Fofonoff et al. 2018
BSU/AIU	Bering Sea	No data	Animal	Atlantic salmon	<i>Salmo salar</i>	Reimer 2017, Brodeur and Busby 1998; Fofonoff et al. 2018
CSU	Kotzebue Sound	No data	Animal	softshell clam	<i>Mya arenaria</i>	Bernard 1979; Fofonoff et al. 2018
GAU	Gulf of Alaska	Wrangall Island, Stikine River	Animal	American shad	<i>Alosa sapidissima</i>	Reimer 2017, Mecklenburg 2002, Hasselman 2012; Fofonoff et al. 2018
GAU	Kachemak Bay	Halibut Cove	Animal	violet tunicate	<i>Botrylloides violaceus</i>	Hines et al. 2000
GAU	Kachemak Bay & Cook Inlet	No data	Animal	hydroid	<i>Opercularella lacerata</i>	Hines and Ruiz 2001
GAU	Kachemak Bay & Cook Inlet	No data	Animal	hydroid	<i>Proboscoidactila flavicirrata</i>	Hines and Ruiz 2001
GAU	Kachemak Bay & Cook Inlet	No data	Animal	hydroid	<i>Garvia franciscana</i>	Hines and Ruiz 2001
GAU	Kachemak Bay & Cook Inlet	No data	Animal	bryozoan	<i>Schizoporella unicornis</i>	Hines and Ruiz 2001
GAU	Kachemak Bay	Jakolof Bay	Animal	softshell clam	<i>Mya arenaria</i>	Hines and Ruiz 2001
GAU	Ketchikan	Homesead Skiff, Promech Air, Cruise Dock, Carlin Air Float, Bar Harbor	Animal	Japanese skeleton shrimp	<i>Caprella mutica</i>	Ashton et al. 2008; Fofonoff et al. 2018
GAU	Ketchikan	Tongass Narrows	Animal	softshell clam	<i>Mya arenaria</i>	Hanna 1966
GAU	Ketchikan	Davidson Inlet	Plant	wireweed	<i>Sargassum muticum</i>	Scagel et al. 1989
GAU	Ketchikan	Tongass Narrows	Animal	golden star tunicate	<i>Botryllus schlosseri</i>	Jurgens et al. 2018
GAU	Ketchikan	Inside Passage	Animal	violet tunicate	<i>Botrylloides violaceus</i>	Ruiz et al. 2006; Cohen et al. 2008; Fofonoff et al. 2018
GAU	Ketchikan	Bar Harbor Marina	Animal	brown bryozoan	<i>Bugula neritina</i>	Reimer et al. 2017; Jurgens et al. 2018; Fofonoff et al. 2018
GAU	Kodiak Island	Three Saints Bay	Animal	softshell clam	<i>Mya arenaria</i>	Nybakken 1969, cited by Carlton 1979; Fofonoff et al. 2018
GAU	Prince of Wales	Kasaan Bay	Animal	Chinese mitten crab	<i>Eriocheir sinensis</i>	United States Environmental Protection Agency, 2017 STORET database

GAU	Prince of Wales Island	Chusini Cove, Kaguk Cove, St. Philip Island, Klawock Marina, S Craig, W Shelikov Island, Farallon Bay, Dunbar Inlet	Algae	red algae	<i>Agarophyton vermiculophylla</i>	Krueger-Hadfield et al. 2018
GAU	Prince of Wales Island	Sea Otter Sound	Plant	wireweed	<i>Sargassum muticum</i>	ALAJ00982, University of Alaska Southeast Herbarium, Fofonoff et al. 2018
GAU	Prince William Sound	Hartney Bay, Orka Inlet, Copper River Delta,	Animal	softshell clam	<i>Mya arenaria</i>	Feder and Paul 1974, cited by Carlton 1979, Powers 2006; Fofonoff et al 2018
GAU	Prince William Sound	Tatilek	Animal	violet tunicate	<i>Botrylloides violaceus</i>	Hines et al. 2000
GAU	Prince William Sound	No data	Animal	boring sponge	<i>Cliona thosina</i>	Hines and Ruiz 2001
GAU	Seldovia	Seldovia Harbor	Animal	Japanese skeleton shrimp	<i>Caprella mutica</i>	Ashton et al. 2008; Fofonoff et al. 2018
GAU	Sitka	Cove Marina, Thomsen Harbor, Crescent Harbor, ANB Dock	Animal	Japanese skeleton shrimp	<i>Caprella mutica</i>	Ashton et al. 2008; Fofonoff et al. 2018
GAU	Sitka	Whiting Harbor	Animal	Dvax; colonial tunicate	<i>Didemnum vexillum</i>	Cohen et al. 2011
GAU	Sitka Sound	Crescent Harbor, Sealing Cove, Thomsen Harbor	Animal	golden star tunicate	<i>Botryllus schlosseri</i>	Ruiz et al. 2006
GAU	Sitka Sound	Sitka Sea Farms, Cedar Beach Rd., Cove Marina, Cresvent Harbor, Galankin Island, Sealing Cove, Thomsen Harbor, Bar Harbor Marina, Casey Moran City Floats, Rogue Cove Marina	Animal	Violet tunicate	<i>Botrylloides violaceus</i>	Lambert and Sanamyan 2001, Ruiz et al. 2006, Cohen et al. 2008; Fofonoff et al. 2018

APPENDIX 2: Communications Strategy

Key Audience	Message	Mode 1	Mode 2	Mode 3	Mode 4
Refuge staff & volunteers	We Clean, Inspect, and Seal because we're a vital link to keep our islands safe from non-native plants and animals.	biosecurity film; swag (Clean-Inspect-Seal stickers/posters, luggage tags)	protocols posted in control points (Homer, Adak, Sitka, etc.)	annual training	biosecurity point person assigned to every crew or cruise
Construction and Cleanup Crews (FUDS-USACE)	Maybe emphasize 1. Non-native species cause harm to natural resources and 2. Biosecurity is practiced by contractors on other refuges?	biosecurity film; permit instructions/checklists	swag	Tim briefs/ trains the health & safety site coordinator	
Scientific Permits	Please Clean, Inspect, and Seal to keep the Refuge wild and free of non-native species.	biosecurity film; annual webinar training	permit instructions/checklists	<i>Tiglax</i> orientation briefing	
Alaska Native Villages & Tribal Governments*	<i>Develop in cooperation with tribes...</i> Clean, Inspect, and Seal to protect traditions of subsistence living?	camps (Kendra)	Aleut Villages Conference and AFN presentation	ATCEM (Nov 2019)	AFE (Feb 2020)
Commercial Permits & Industry	Please Clean, Inspect, and Seal to protect Alaskan harvest and tourism industries from non-native plants and animals	biosecurity film; permit instructions	swag?	pre-season presentation/training with operators and interest groups like Alaska Marine Conservation Council	boot washing manual
Hunters, Trappers, Anglers	Please Clean, Inspect, and Seal to keep the Refuge wild and free of non-native plants and animals.	flyers at key Fish & Game offices	ad in Regulations handbook?	update Adak caribou FAQ on Refuge website	provide Lisa w/ flyers/checklists
Department of Defense	Please Clean, Inspect, and Seal to keep the Refuge wild and free of non-native plants and animals.	Refuge manager briefs operation leader	distribute checklists		
"Back door" general public (including private boaters)	Clean, Inspect, and Seal to keep Alaskan National Wildlife Refuges wild and free of non-native plants and animals	buy ads in Alaska Business Monthly? Make the messaging for ALL AK NWRS (they could help \$)	partnership w/ Alaska Geographic for swaggy products that get widely sold to tourists across state	visitor center programming	social media and newsletter posts about Refuge non-natives

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***Swag contacts:** work with Jeff Williams or Aaron Martin, Alaska Region Invasive Species Program Coordinator (aaron_e_martin@fws.gov)

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APPENDIX 3: *TIGLAX* Briefing (*in progress*)

This is a script for a standardized, spoken briefing to be delivered to visitors to the Refuge, likely during orientation on the R/V *Tiglax*. *Will need to be edited and refined by the mate as they see appropriate.*

Biosecurity is important to the Alaska Maritime National Wildlife Refuge. Past research and other contracted activities (in addition to a history of exploration and industry) have accidentally and intentionally introduced non-native species to Refuge lands. For example, there is annual bluegrass on the trail to the Aiktak cabin that most likely came from Refuge biologists.

While aboard the *Tiglax* and out visiting Refuge lands, you will need to follow some simple protocols to help prevent the introduction and spread of non-native plants and animals. Most importantly, please take our core biosecurity practice of *Clean, Inspect, Seal* to heart. Everything that arrives on Refuge land should be *cleaned* to remove organic material and kill pests, *inspected* for remaining hitchhikers and pests, and *sealed* from incursion (in other words, stored in a way that prevents exposure to hitchhikers and pests).

Boarding the *Tiglax*

- You should have already received pertinent biosecurity protocols and arrived prepared
- Your luggage should be vacuumed and free of dirt, debris, and any vegetative matter
- Your clothes and shoes should be laundered and clean of debris
- Equipment that comes into contact with animals should be cleaned and sanitized
- All other equipment should be clean and free of dirt, debris, and plant matter
- **If you did not properly prepare, please deposit your bags in the wet lab (or other secure containment area) and complete these tasks before unpacking in your stateroom**

Going Ashore (repeat during every skiff deployment)

- When it is time to go ashore, we will assemble on the back deck and put on float suits or coats and scrub boots
- Please allow plenty of time to scrub your boots before boarding the skiff
- This is the boot wash station [*demonstrate how it works, ask people to practice using it, give feedback*]
- Inspect the velcro and cuffs of the float suits or coats for seeds/plant matter before boarding the skiff
- If you find any seeds, remove them and place in garbage (NOT OVERBOARD) [*show where forceps are stored*]
- Once on shore, remove float suits/coats below the high tide line and place into a spare drybag for storage

Returning to the *Tiglax*

- Inspect clothing for insects and plant matter, and remove on shore
- Inspect your other belongings like backpacks and tripod feet for debris. Remove before boarding the skiff.
- Once back on the *Tiglax*, proceed immediately to the boot wash station and clean all shoes worn ashore. *Priority goes to folks who are headed up to skiff deck to help with skiff loading.*
- Please do not bring any plants, flowers, or live animals back to the *Tiglax* unless you have a special collection permit.

APPENDIX 4: Best Practices for Refuge Activities

INTER- AND INTRA- ISLAND MOVEMENT AND NON-*TIGLAX* ANNUAL FIELD CAMPS

Plan ahead

- Familiarize yourself with known infestations on the island prior to travel. Refer to Appendix 1 for islands with known infestations.
- Know how to identify common invasive plant species. [This Invasive Species Pocket Guide for Alaska Firefighters](#) contains photographs and other information to help identify invasive terrestrial plant species across Alaska. Print this guide and carry in the field to help identifying invasive plant species. Similarly, the Alaska Weeds ID app (available here: <https://apps.bugwood.org/apps/alaska/>) has an interactive key to identify plant species and will work offline. We encourage people to download this application on their mobile work phones or tablets. This app can also streamline reporting if new infestations are discovered. Lastly, [this website](#) also provides a more comprehensive guide to non-native plants in Alaska.

Boarding

- Luggage should be vacuumed and free of dirt, debris, and any vegetative matter
- Clothes and shoes should be laundered and clean of debris
- Equipment that comes into contact with animals should be cleaned and sanitized
- All other equipment should be clean and free of dirt, debris, and plant matter

Going Ashore (repeat during every skiff deployment)

- Inspect the Velcro and cuffs of float suit or coat for seeds/plant matter before leaving the ship
- Remove any seeds or other items and place them in garbage [*do not throw overboard*]
- Scrub boots before leaving the ship
- Once on shore, remove float suits/coats below the high tide line and store in a spare drybag

When in the field

- Whenever possible, do not travel through infested areas. If work must occur in infested areas, plan work so that these areas are visited last. Avoid moving from infested areas to uninfested areas whenever possible.
- Do not park vehicles or stage equipment or supplies in infested areas.
- Choose equipment that minimizes vegetation and soil disturbance. Limit the use of untreated wood brought to field locations.
- Avoid placing soft sided materials that can easily pick up seeds (clothing, backpacks, etc.) directly on the ground. Instead place them on tarps, vehicles, inside totes, etc.
- Boat launches and airports are especially high-risk areas. Avoid parking or backing trailers or other vehicles through vegetation at these sites to avoid picking up seeds or other plant parts.

Clean, Inspect, Seal

- Use bristle brushes, brooms, scrapers and other hand tools to remove soil, debris and vegetation from shoes and other equipment to the greatest extent possible when moving between sites intra-island. This should always been done if traveling between areas with known infestations.
- Always clean clothing and equipment when moving inter-island. Hand tools can be effective for cleaning in the field if the ship or other control point will not be visited between inter-island movements.
- Visually inspect totes and gear. Physically remove any plant or other organic material prior to moving them inter-or intra-island.
- Inspect all clothing after cleaning in the field. Inspect coworkers, and inform them about possible seeds or other propagules carried on their clothing, footwear, and gear.
- Use special gear as appropriate such as nylon gaiters to cover socks and laces, use leather laces on leather boots, or use rubber boots to reduce risk of picking up seeds.
- While at field camp, keep food items, especially things like flours and grains, which can harbor pests, sealed in secondary containers. In general, keep all food in lidded bins or totes whenever possible.
- Once back aboard the ship, proceed immediately to the boot wash station and clean all shoes worn ashore.
- Do not bring any plants, flowers, or live animals aboard the ship unless you have a special collection permit.
- When traveling between sites by non-Tiglax means (charter boats, aircraft), bring hand-held cleaning tools to clean and inspect all gear prior to boarding the boat/plane.

WAREHOUSES AND OTHER FACILITIES

Procedures common to all locations

CLEAN

- Clean gear, vehicles, and other equipment according to protocols outlined in Part II of this document at a minimum of two time points:
 1. Prior to being loaded onto a research vessel or otherwise being taken out into the field; and
 2. Prior to off-season storage at the warehouse
- Reduce or eliminate non-native plant species growing near to warehouse or parking areas. Clear vegetation within 2 feet of structures and parking areas, cut back limbs within 6 feet of structures. Treat non-native plant species if appropriate.
- Do not keep food in the warehouse. If absolutely necessary, ensure any stored food items are kept in rodent-proof containers.
- Vacuum and mop (if possible) interior of the warehouse in the spring to ensure that the presence of non-native plant seeds or animal pests are eliminated prior to field camp preparation.
- Keep external area of warehouse clear of unneeded debris. Particularly untreated wood that may harbor insect pests.

INSPECT

- Regularly inspect warehouse interior and exterior for signs of rodents and for areas where they may obtain entry to the building. Rodents can enter through any hole >1/4 inch in size.
- Regularly inspect trapping stations (see detail below).
- Regularly inspect warehouse exterior to ensure that plants and vegetation are cleared. Identify non-native plant species and determine need for treatment.

SEAL

- Ensure that all lumber, equipment, construction materials, and other items that are stored outside are located at least 30 feet away from the buildings and raised 18 inches off of the ground.
- Maintain a gravel/rubber mulch vegetation free-perimeter around building and parking areas.
- All items stored outside should be covered in tarps to prevent incursion of animal and plant pests.
- Items should be placed on shelves or pallets. Ensure items that rodents or insects could gain entry into are stored in rodent-proof containers.
- Items stored on shelves should be sealed in secondary containers whenever possible to prevent incursion of pests. If using cardboard, tape boxes closed to enable identifying if rodents or other pests have gained entry.
- Keep doors closed when working inside the warehouse whenever possible.
- Seal all holes or entry points into the building >1/4 inch with metal screens or other rodent-proofing materials. Place weather strips on doors if they have gaps >1/4 inch.
- Eliminate potential rodent water sources available for rodents (ensure water is not allowed to pool, no leaking faucets, etc.).

Considerations for storage facilities in locations other than Homer

Sitka

- Keep the Refuge designated storage locker clean and tidy. Sweep prior to loading and unloading items.
- Clean gear prior to storage and again when packing as necessary.
- Do not store food or other attractants within the storage locker.
- Seal items in rodent-proof containers whenever possible to prevent pest incursion.
- Inspect all gear when packing and before departing to ensure that incursions of rodents or other pests has not occurred.

Adak

- Adak warehouse supports known infestations of rodents. Use EXTREME care when loading items from this storage area.
- Anything that can be stored in rodent-proof containers should be. Tightly seal lids and inspect seals when packing and unpacking to ensure no rodents or other pests have obtained entry.
- Large items that cannot be stored in rodent-proof containers such as weatherports, boat and data-logger rigging equipment, cooperators gear stored in boxes or drybags, tents and sleeping bags, etc. MUST be expected thoroughly before packing and loading.
- Ensure that items are inspected and packed on the same day they will be loaded or that they are stored in a rodent-proof area until loading.

RODENT DETECTION AND TRAPPING

Suggested Traps and Detection Devices

- TRex traps (target rats)
- TRex mini traps (target mice)
- Protecta stations for traps
- DETEX detection blocks

Warehouse trapping protocol

(Adapted from Badzik et al. 2014)

Place traps. Place rodent traps at regular intervals along walls in areas near doorways, observed rodent activity, and in places where they will not be disturbed by ongoing activities in the interior of the warehouse. Additional detail for trap placement can be found below in the Details for Rodent Detection and Assessment Techniques.

- In locations with no known rodent activity, place traps along walls in intervals of ~ 40 feet.
- In warehouses with known rodent activity, place traps at more frequent intervals (every ~20 feet).
- In the interior of the building, traps do not need to be placed inside of Protecta stations, as this makes them easier to check and to determine if activity has occurred. However, if there is concern about traps being sprung through warehouse activities, they may be placed inside Protecta stations. If traps will be placed outdoors, they must always be placed inside Protecta stations.
- Each 'station' should consist of a TREX brand rat trap and a TREX Mini trap (placed directly in warehouse near to each other, or inside of a Protecta station). DETEX detection blocks can be used as needed, though these are best placed inside of Protecta stations.

Check traps. In areas where rodents are not regularly detected, monthly checks of stations are sufficient (printable checklist below). In areas where rodent activity is expected check traps weekly (or even daily if infestations are severe).

- During each check re-set traps as needed, refresh bait, and inspect DETEX blocks for signs of rodent activity.
- If any activity has occurred, use the UV/black light flashlight to search for rodent droppings- they will fluoresce. Remove and dispose of any carcasses.

Increase trap pressure if rodents detected. If a rodent is captured in a trap, or evidence of rodent activity in the warehouse is observed, place additional traps directly in the areas where droppings, chew marks, bedding, bodies, etc. are observed.

- The number of additional traps to be used in an area of observed activity will depend on the severity of the infestation. Ensure proper placement of traps (detail below).
- Check all traps daily or weekly (depending on severity of infestation) until animals are no longer being captured.
- If no animals are captured and evidence of activity subsides for a period of several weeks, then the density of traps can be decreased to every ~40 feet and checked on a monthly basis.

Toxicant policy. No poison will be used in routine rodent prevention procedures; the focus instead is on maintaining traps and monitoring detection blocks. The use of toxicants will be reserved for situations when rats have been detected but are eluding capture.

Example trapping station checklist

TREX (<input type="checkbox"/>)	Capture? (circle one)	TREX MINI (<input type="checkbox"/>)	Capture? (circle one)	DETEX blocks (<input type="checkbox"/> /replaced?)	DETEX Activity?	Extra Trap details Or other notes
DATE						
Station 1	Y / N		Y / N		Y / N	
Station 2	Y / N		Y / N		Y / N	
Station 3	Y / N		Y / N		Y / N	
Station 4	Y / N		Y / N		Y / N	
Station 5	Y / N		Y / N		Y / N	

Details for rodent detection and assessment techniques

(Selected excerpts from Fritts 2007)

A variety of tools and techniques exist for identifying an infestation. They include inspecting for rodent sign; setting out sticky boards, tracking boards, and snap traps; and using black lights to locate urine trails. The following section provides details.

Rodent Sign Since rats and mice are active at night and not typically seen during the day, it is necessary to recognize signs of their activity.

Droppings and Urine -Most people first recognize rodent problems by finding droppings (Fig. H-9) or urine stains in and around buildings. Droppings may be found along run ways, in feeding areas, and near shelter. Rodents usually have favorite toilet areas but will void almost anywhere. Old droppings are gray, dusty, and will crumble. Fresh droppings are black, shiny, and puttylike in texture. Rodents urinate while running, and the streaks are characteristic. The urine glows under ultraviolet lights and glows blue-white when fresh.



Figure H-9. Droppings of roof rat (1/2", left), Norway rat (3/4", middle), and house mouse (1/8", right).

Gnawed Objects - Rodents gnaw daily in order to keep their teeth short and sharp; rats also gnaw to gain entrance or obtain food. Teeth marks on food, building materials, wire, and edges of beams are indications of gnawing. Gnawing may be visible on doors, ledges, in corners, in wall material, on stored materials, or other surfaces wherever rats are present. Fresh accumulations of wood shavings, insulation, and other gnawed material indicate active infestations. Fresh gnawing in wood is usually light-colored with sharp, splintery edges. Old gnawing is smooth and darker. Size of entry holes (often 3.8 cm [1.5 in] in diameter or less for mice, 5.1 cm [2 in] or larger for rats) or tooth marks can be used to distinguish rat from mouse gnawing.

Runways - Rats habitually use the same paths or runways between harborage and food or water. Runs or burrows may be found next to walls, along fences, next to buildings, or under bushes and debris. Outside runways are paths 5.1 – 10.2 cm (2 – 3 in) wide and appear as smooth, hardpacked trails under vegetation. Indoors, runways are usually found along walls. Rats memorize pathways and use the same routes habitually. The presence of undisturbed cobwebs or dust indicates runways are not being used.

Rubmarks - Along runways, dark greasy rubmarks appear from contact with oil and dirt on the rodent's body. Rubmarks on walls, beams, rafters, and pipes appear as black smudges left by the rodent. New rubmarks are soft and will smudge. Old rubmarks are brittle and will flake when scratched. Rafters may show swing marks if roof rats are present (see photo at: <http://www.msosquito.com/pdf/Rat.pdf>).

Tracks – Rodent footprints or tail marks may be seen on dusty surfaces or in mud (Fig. H-10). In winter, rodent tracks are frequently visible in the snow between homes and other structures (R. Sinnott, ADF&G, Pers. Comm. 7/25/06).



Figure H-10. Rat tracks in mud.

Burrows -Norway rats burrow for nesting and harborage. Burrows are usually found in earth banks, along walls, under rubbish and concrete slabs. Freshly dug dirt scattered in front of 7.6cm (3-in) openings with runways leading to the openings is characteristic. Burrows usually are 45.7 cm (18 in) deep in most soils. Slick, hardpacked runways indicate an old established colony.

Live Rats and Dead Rats - The sighting of live rats is a sure sign of infestation. Sightings in the daytime indicate large populations, or a response to an upset such as disease or poisoning. The presence of mummified rat carcasses may indicate a former infestation but finding many fresh carcasses suggests disease or poisoning.

Sound - Sounds such as gnawing, climbing in walls, clawing, various squeaks, and fighting noises are common where rats are present, particularly at times of the day when they are most active (Timm 1994) or in quiet areas. The young often squeak while in the nest.

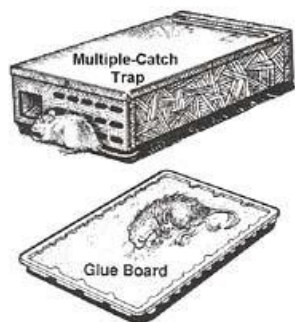
Trapping

Sanitation and rodent-proofing work together to enhance the effectiveness of trapping and baiting; all are components of an integrated rodent management program. Removing food sources and restricting rodent access forces rodents to roam farther away from their nests in search of food, making their contact with rodent traps and baits more likely.

The use of rodent traps and/or rodenticide/poison baits depends on the situation. Several problems with the use of traps are: trap shyness, bait shyness, evasive maneuvers and learned behaviors, and genetic resistance to rodenticide baits. Each of these will be discussed in following sections.

As with any IPM program, selection of the best methods for trapping needs to occur after careful inspection, pest identification, and assessment of the situation. While rodenticide (poison) baiting is often the best way to quickly control sizeable rodent infestations, in many situations trapping has advantages over baiting. Trapping does not use rodenticides, and trapped rodents can be regularly discarded so no odor problems result. Trapping can provide a reasonable means of initially assessing the size and characteristics of a rodent population.

Glue Board trap consists of a sticky film of glue applied to a backing of cardboard, wood or plastic. Glue boards can be constructed by placing special glue in pie tins or paper plates. The glues do not harden but will hold a rat in place. Other rats become curious and also get caught. Placing a small piece of food bait in the center of a glue board can increase effectiveness.



H-11. Trap and Glue Board

For other than a quick assessment, the use of glue traps (glue boards) should be limited; when used as part of control or eradication efforts, glue boards should always be combined with other methods. These traps can fail when they get dirty, or too hot or cold. To help keep them free of dirt and moisture, glue trap covers can be used. Alternatively, the traps can be placed in boxes with openings, in empty bait stations, and so on. Even with these precautions, however, savvy rodents will avoid them, vault over them or place debris on them to cover the sticky surface. Some people consider the glue board to result in inhumane deaths of rodents (i.e., through dehydration or starvation).

Snap Traps and Multiple Catch Traps -Traps are most useful against mice, because mice tend to be curious and rats suspicious. For mouse control in public buildings, snap traps and multiple-catch traps can be used. One multiple-catch trap can trap a dozen or more mice -- without the use of rodenticide/poison bait or pesticide.

Because some people are unwilling to kill or touch mice, they purposefully select glue boards or a live trap. Unfortunately, they then release to the outdoors any mice they catch, allowing the former captives to reinvade the same or another structure. For this reason, use of live traps for capturing mice is strongly discouraged. If you catch mice, kill them or give them to a snake owner. Captured mice should never be released alive to the outdoors! Also, be aware that owning a cat that is allowed to hunt outside may increase the risk of live mice or other small mammals (voles, shrews) being brought indoors.

Unlike snap traps, multiple-catch traps are not useful against rats. The best all-around trap for both mice and rats is the snap trap (or break-back trap). Modern snap traps have expanded plastic triggers proven to catch more rodents than older traps with smaller, metal triggers (Fig. H-12). The Victor Professional kill trap has been highly recommended in the past (New Zealand Department of Conservation 2002) but may be best suited for household, warehouse, and community use.

Other brands have been found more reliable; these include traps primarily made of plastic, for use in protective stations (Dunlevy and Scharf 2007a). Meanwhile, the “search is on for a better mouse- (or rat-) trap.” A newly developed “reverse-bait trigger” trap by Ka Mate Limited appears well suited to use in outdoor or other heavy-use settings in Alaska because it is less prone to misfires (e.g., from jostling or shipboard vibration) or to trapping of animals such as birds. Made of aluminum, it is particularly durable and can be bolted into place (A. Sowls, FWS/AMNWR Wildlife Biologist, Pers. Comm. 4/6/07).

Although snap traps are effective in many situations, they are generally too labor-intensive and time-consuming to be practical against large infestations of rodents. Half a dozen snap traps will capture a couple of mice in someone’s kitchen, but two dozen may be required for a typical restaurant storage room, and many more are needed in a warehouse. Since mice travel only 3-9 m (10-30 ft) but rats travel 30.4 – 45.7 m (100-150 ft) from harborages, more traps are needed to trap mice than rats in a structure. Snap traps should be placed at 3-m (10-ft) intervals for mice and at 6-m (20-ft) intervals for rats. Both types of rodents are used to human odors so there is no need to use gloves when handling unbaited traps or traps baited with non-toxic (e.g., food) baits.

Runway traps – Designed to catch rats when they accidentally bump the trigger, runway traps are available commercially or can be made from snap traps by enlarging the trigger with cardboard, hardware cloth, paperclip, or screening. There is no bait to go stale, so there is an increased chance of success.

Trap Placement Considerations – Rats and mice have different behaviors around new objects. Mice are curious and will normally approach traps the first night. If you don't catch a mouse in the first few nights, the trap is in the wrong location. Whether baited or not, it is important to place traps where the rodents are, and to consider innate rodent attributes and behaviors.

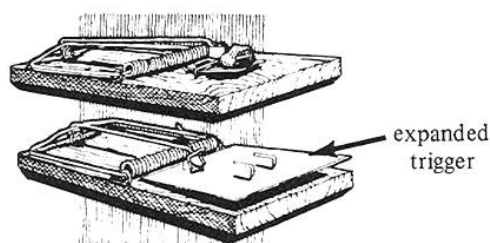


Figure H-12. Expanded trigger trap.

Because rodents tend to run along walls, it is important to place snap traps perpendicular to the wall (i.e., at right angles to rat runs), with the trigger end against the wall. They can also be placed in tandem (back-to-

back), parallel to the wall, so that rodents traveling in either direction will encounter the triggers. For examples of correct and incorrect placement of snap traps, see Fig.H13. Traps can also be nailed, wired, or clamped to rafters and beams to take advantage of areas where rats travel.

Trap and/or Bait Shyness – Neophobia makes rats hesitant to approach new items such as traps or rodenticide bait placed into their environment. Rats may ignore newly-placed rodent bait and traps for days or even weeks, particularly if other food continues to be routinely available. Allow rats to overcome trap shyness by placing traps unset, in place, for several days. This results in better catches.

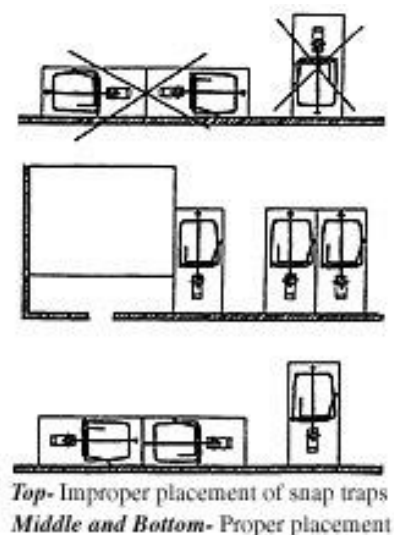


Figure H-13. Correct placement of traps: improper (top) and proper (middle and bottom)

Another strategy is to “pre-bait” snap traps without setting them. Pre-baiting allows rats to adjust to presence of the traps and begin feeding on the food bait. Once routine feeding occurs, the triggers can be set. The object is to maximize the number of rodents caught and minimize the number of escapees. This is important for overall success because “experienced” individuals may train others to avoid poison-contaminated food, or they may transfer their wariness to nontoxic foods of similar types. This type of bait shyness can persist for weeks or months.

Baiting

Traps are usually effective when dealing with small numbers of rats or mice. Although unbaited snap traps do catch rodents, they work best when baited with food the rodents find attractive. The food bait must compete with other available foods, so no single food bait is ever the best bait for all locations. Rodents living on garbage or spoiled food prefer something fresh. Following are some food baits that have proven successful for rodents:

- Whole nuts for rats and mice
- Raisins or grapes for roof rats
- Sardines packed in oil, or sponges soaked in herring oil, for Norway rats
- Peanuts or peanut butter for rats and mice (soak whole peanuts in water overnight; old peanut butter becomes rancid so replace it frequently)
- Dry oatmeal is excellent for mice, and for either species oatmeal or rolled oats can be made into a paste by mixing with peanut butter.
- Bacon squares, hot dogs, sardines
- Small wads of cotton (e.g., cotton balls) for mice and rats (desired as nest material)

- Gumdrops for mice
- Especially if trapping rodents in an outdoor setting, it is important to adapt food bait locally.

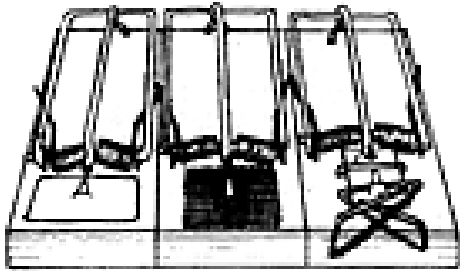


Figure H-14. Runway traps made from enlarged snap traps.

Recommendations on Trap Use and Maintenance

- Use mouse traps wherever there is evidence of mouse activity; rat traps are too large to be effective for mice. The converse is also true. Use the correct-sized trap for the intended species.

- Bait station and trap placement for rats:

- ~“Think like a rat” when picking optimum locations for placement of treatment devices, particularly traps; as appropriate, use a tracking powder (flour, talc) to pinpoint the best places along suspected runways to place traps.

- ~Initially use unset traps, no rodenticide bait in bait stations, and/or no toxicants in bait, for at least several days to address rats’ neophobia. (An attractant that is similar to the intended bait can be sprinkled on unset traps or in unbaited bait stations during the “pre-bait period”; examples include herring oil if herring oil-soaked sponges will be the bait, or a mixture of peanut oil and rolled oats if a sticky mix of peanut butter and rolled oats is planned as bait [Dunlevy and Scharf 2007a].)

- Set all traps to kill: Rat escapees learn to avoid and may teach their young.
- Use a combination of snap traps, sticky boards, and poison bait boxes for best results.
- Place traps in dark areas against walls (along rodents’ travel paths); also place traps in areas of food, garbage, and freight storage, and near holes; set traps where children and pets will not be hurt.
- One benefit of using traps rather than bait stations is to control where the rodents, and rats in particular, die. To prevent rats from dragging traps away, nail or otherwise anchor the traps in place.
- Place rodenticide baits and bait stations near, but not on, rat runways. Rats will quickly find them and, after a period of avoidance, will cautiously investigate them.
- To boost chances for success, set traps as double set (side by side); traps can also be placed in tandem (back-to-back), parallel to the wall so that rodents traveling in either direction will encounter the triggers.
- Set baited traps or runway traps at right angles to rat runs (Fig. H15). A board or box can be used to narrow a runway and help guide rats into traps.
- Especially for food or not-toxic baits, thwart bait stealing by using dental floss or a twist-tie to tie baits onto snap trap triggers. To hold the trap in place on pipes or rafters, use rubber bands, nails, or hose clamps. Traps can also be nailed to rafters and beams to take advantage of areas where rats travel.
- Extend the life of snap traps by wire brushing and oiling springs if rusty.
- Regularly check the traps to make sure they are set, in good condition, and that any food or rodenticide baits used are fresh; moldy bait is less effective.

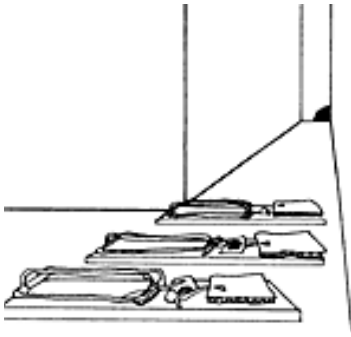


Figure H-15. Traps at right angles to rat run

APPENDIX 5. Diagrams and Checklist for Inspection/Decontamination of Vehicles and Heavy Machinery.

Diagrams courtesy of Ontario Invasive Plant Council via “Keeping it Clean – A Tasmanian Field Hygiene Manual to Prevent the Spread of Freshwater Pests and Pathogens”.

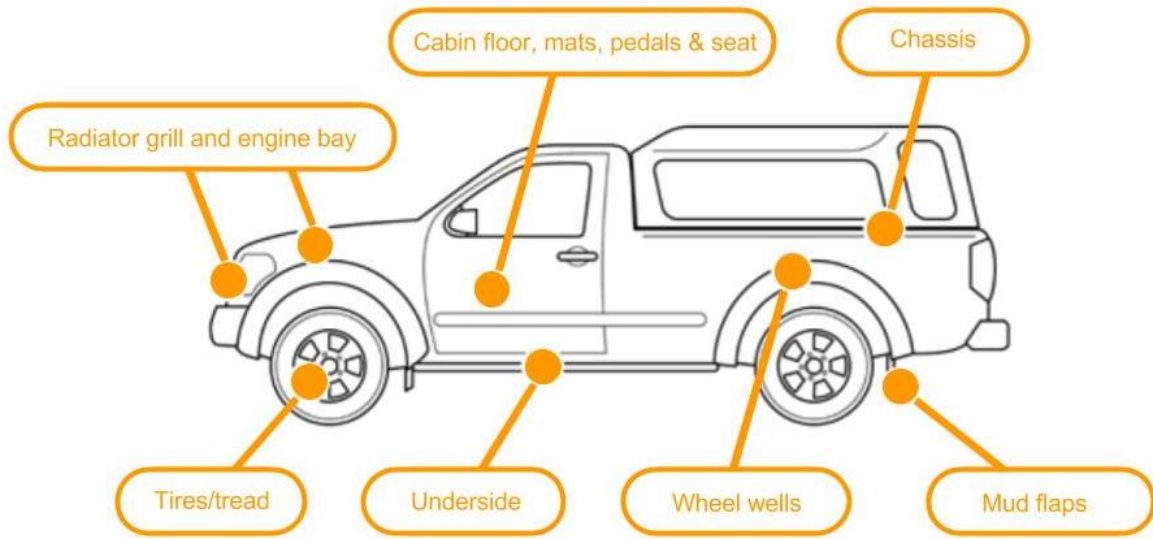
For a detailed, step-by-step manual on vehicle and machinery cleaning practices, see:

[Halloran, Joe, Anderson, Hayley and Tassie, Danielle. 2013. *Clean Equipment Protocol for Industry: Inspecting and cleaning equipment for the purposes of invasive species prevention*. Peterborough Stewardship Council and Ontario Invasive Plant Council. Peterborough, ON.](#)

For information on impacts of Quat on different equipment surfaces, see:

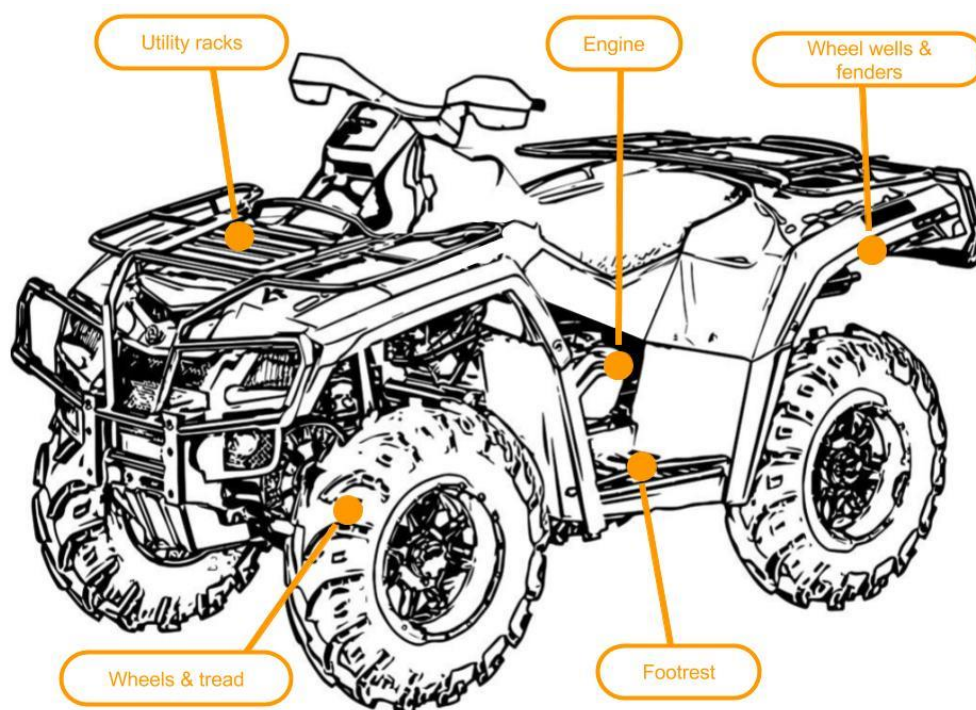
[McBride, Greg. 2013. *Testing Quaternary Ammonium Products \(aquatic invasive species decontaminants\) for Corrosive Effects to Fire Equipment*.](#)

Rubber-tired vehicle: Traditional



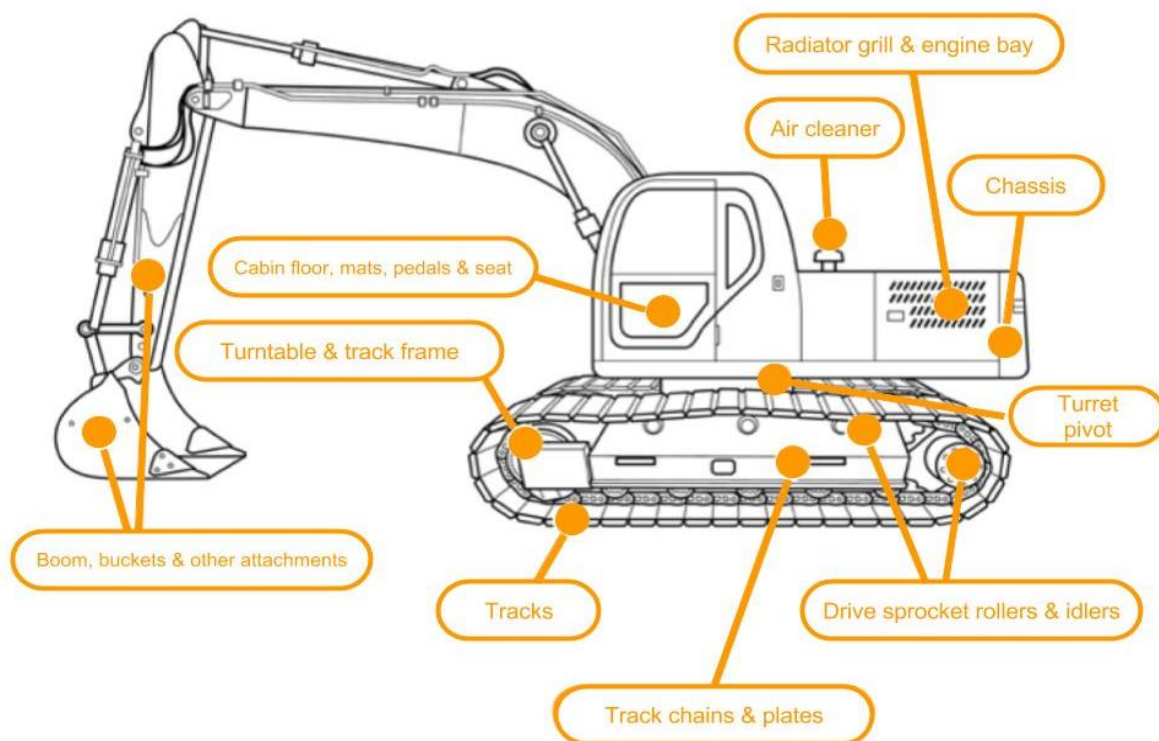
Region	Parts	Cleaning Action	✓
Cabin	Floor, mats, pedals, seats	Vacuum, wash where appropriate. Fumigate.	
Engine	Radiators, engine bay, grill	Steam clean or air blast	
Body	Underside, chassis, crevices, ledges, bumper bars	Pressure wash	
Wheels	All wheels including spare, wheel wells, mud flaps	Pressure wash, spray with Quat or bleach	
Truck bed	Floor, canopy (if applicable)	Vacuum, wash	

Rubber-tired vehicle: Off-Road



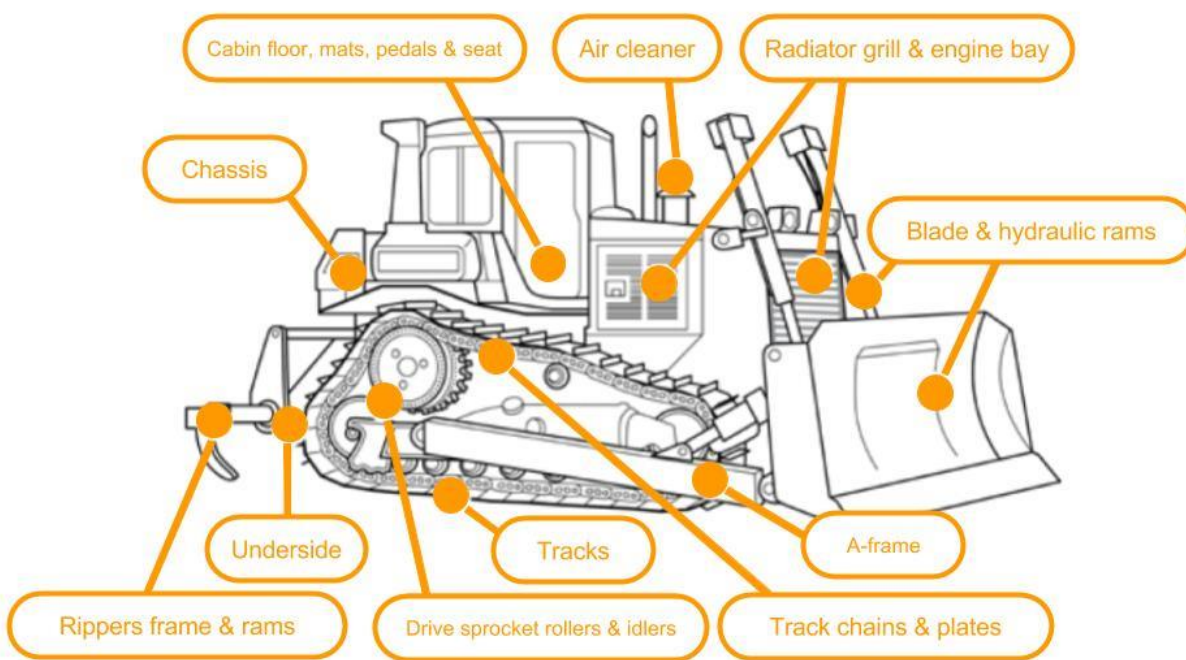
Region	Parts	Cleaning Action	✓
Body	Underside, crevices, ledges, footrest	Pressure wash, spray with Quat or bleach	
Racks	Front & rear utility racks	Pressure wash	
Wheels	All wheels, wheel wells & mud flaps	Pressure wash, spray with Quat or bleach	
Engine	Engine compartments, exhaust	Steam clean or air blast	

Excavator (Heavy equipment, tracked)



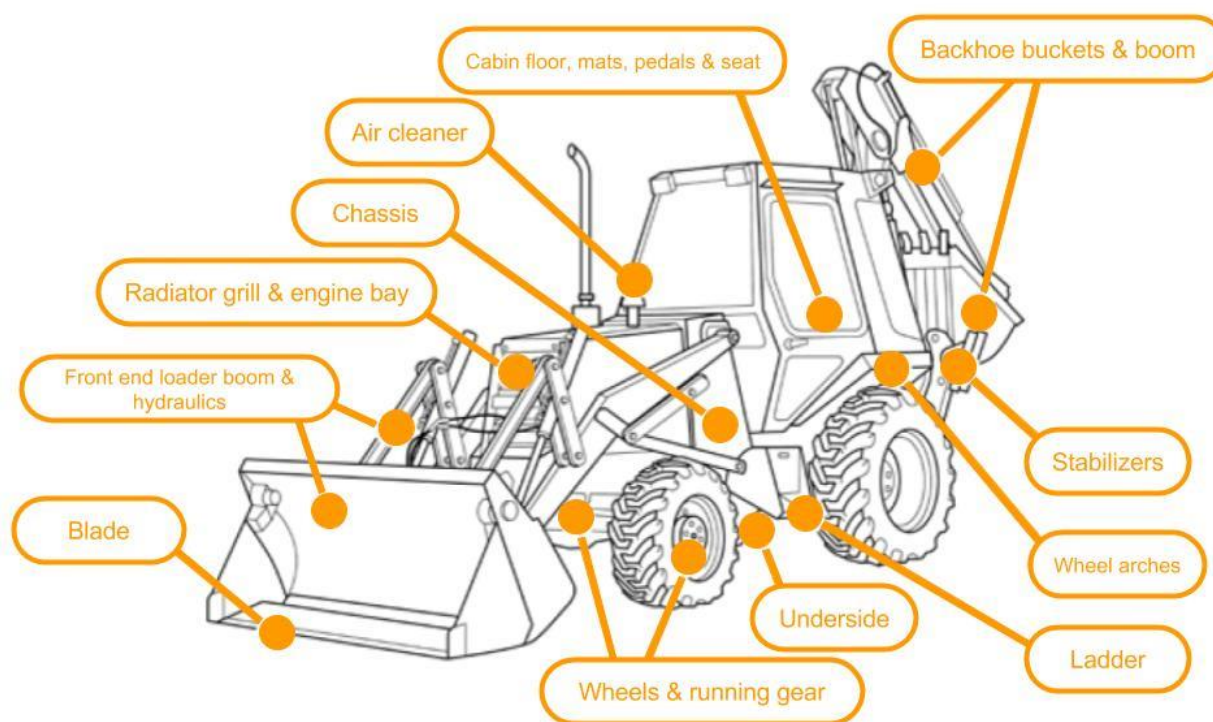
Region	Parts	Cleaning Action	✓
Cabin	Floor, mats, pedals, seats	Vacuum, wipe down where necessary. Fumigate.	
Engine	Radiators, engine bay, grill, air cleaner	Steam clean or air blast	
Tracks	Tracks, track frame, drive sprocket rollers, idlers	Pressure wash. Spray with Quat or bleach	
Body plates	Plates of cabin	Pressure wash	
Body	Ledges, channels, turret pivot	Pressure wash	
Boom	Boom, bucket, other attachments as applicable	Pressure wash, spray with Quat or bleach	

Bulldozer (Heavy equipment, tracked)



Region	Parts	Cleaning Action	✓
Cabin	Floor, mats, pedals, seats	Vacuum, wipe where appropriate. Fumigate.	
Engine	Radiators, engine bay, grill, air cleaner	Steam clean or air blast	
Tracks	Tracks, track frame, drive sprocket rollers, idlers	Pressure wash, spray with Quat or bleach	
Body plates	Belly plates, rear plates	Pressure wash	
Body	Ledges, channels	Pressure wash	
Blade	Pivot points, hydraulic rams, A-frame	Pressure wash	
Ripper	Ripper frame, ripper points	Pressure wash, spray with Quat or bleach	

Backhoe (Heavy equipment, rubber tired)



Region	Parts	Cleaning Action	✓
Cabin	Floor, mats, pedals, seats, ladder	Vacuum and pressure wash where applicable. Fumigate.	
Engine	Radiators, engine bay, grill, air cleaner	Steam clean or air blast	
Wheels	All wheels, wheel arches, guards	Pressure wash, spray with Quat or bleach	
Front end loader	Blade, hydraulics, booms	Pressure wash, spray with Quat or bleach	
Backhoe	Buckets, boom, hydraulics, stabilizers	Pressure wash, spray with Quat or bleach	

APPENDIX 6: Risk and Research Needs Repository

This appendix details specific protocols not accounted for in Part I, Part II, or the appendices, and remain to be addressed.

- Consider adapting or updating suggestions from Steve Ebbert's 2007 HACCP for delivering cargo to field camps
- **BOOT WASHES**
 - Need to set up more than one on the back deck. Split the existing hose and/or install a second one on the port side of the line table during the upcoming retrofit.
 - Work with Andy to develop and weld a nice prototype (or two). At the very least, purchase stiff brushes and some totes to use until the prototype is finished. Should be sturdy and not require people to bend over or balance on one leg. Should be storable in the wet lab or bolted to deck. Should contain scrubbing and rinsing elements. Brushes need to be replaceable after they wear down.
 - If boot wash contains a trough: Change out boot wash water at set times during each watch (1200h and 2400h?). Sea water does not kill seeds. The boot wash water will need to be poured through a sieve and the seed contents placed in the garbage.
 - Institutionalize a ship-shoe/shore-shoe policy. Shore shoes live in the containment zone when they are not in use.
- Passenger clothes being worn on multiple islands while underway. Boots are getting washed regularly but what about clothes? Are people expected to wash clothes after wearing them on an island? Just wash the layers that were exposed to seeds? Washer capacity probably cannot handle this.
- **BIOSECURITY POINT PERSON.** The cruise leader will designate a biosecurity point person (non-crew) to assist with biosecurity protocols during the cruise. This person will give a 15-minute heads-up call to passengers before skiff deployment to ensure plenty of time for biosecurity practices, assist passengers with learning Clean/Inspect/Seal, help check boots, clothes, and jackets, help the crew with trap checks and skiff cleaning if they request it, and stand by during skiff return for footwear transitions/boot washing when speed is important.

Shopping list for Tiglax 2021 operations:

- Bootwash set up
- Quat (to be available for animal-handling scientists to sanitize sampling tools)
- ~14 forceps/forcep container
- Insect traps, fly tape
- Back deck signage: Clean Inspect Seal

These are risks we acknowledge and have discussed but need more time and information to properly address:

- PEAT for annual camp PIT TOILETS (is this a concern?)
 - Commercial sphagnum peat moss (dried) is pasteurized so the risk associate with multicellular invasive species (insects, worms, etc.) is thought to be small. However, a 2015 study found that viable ectomycorrhizal fungi are capable of being transported in peat (Ángeles-Argáiz et al. 2015).
- The big issue of MIXED OWNERSHIP islands. Pribilofs—the crews live off refuge and commute on daily.
- Need more research on terrestrial invertebrate risks: outsource research to UA Cooperative Extension Integrated Pest Management and Derek Sikes (UA Entomologist)

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